

NAVAL POSTGRADUATE SCHOOL

Monterey, California



THESIS

**GROUP COLLABORATION IN ORGANIZATIONS:
ARCHITECTURES, METHODOLOGIES AND TOOLS**

by

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March 2002

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Report Documentation Page

Report Date 29 Mar 2002	Report Type N/A	Dates Covered (from... to) -
Title and Subtitle GROUP COLLABORATION IN ORGANIZATIONS: ARCHITECTURES, METHODOLOGIES AND TOOLS	Contract Number	
	Grant Number	
	Program Element Number	
Author(s) Baasch, Werner	Project Number	
	Task Number	
	Work Unit Number	
Performing Organization Name(s) and Address(es) Naval Postgraduate School Monterey, California	Performing Organization Report Number	
Sponsoring/Monitoring Agency Name(s) and Address(es)	Sponsor/Monitor's Acronym(s)	
	Sponsor/Monitor's Report Number(s)	
Distribution/Availability Statement Approved for public release, distribution unlimited		
Supplementary Notes The original document contains color images.		
Abstract		
Subject Terms		
Report Classification unclassified	Classification of this page unclassified	
Classification of Abstract unclassified	Limitation of Abstract UU	
Number of Pages 141		

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REPORT DOCUMENTATION PAGE			<i>Form Approved OMB No. 0704-0188</i>	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE March 2002	3. REPORT TYPE AND DATES COVERED Master's Thesis	
4. TITLE AND SUBTITLE: Group Collaboration in Organizations: Architectures, Methodologies, and Tools			5. FUNDING NUMBERS	
6. AUTHOR(S) Baasch, Werner K.				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A			10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited			12b. DISTRIBUTION CODE	
13. ABSTRACT (maximum 200 words) <p>In a world that is increasingly more connected using networks of all types, collaboration becomes a way to leverage these connections to benefit both individuals and organizations. Currently there are numerous technologies available, to support different types of collaboration. In order to make informed decisions, it is necessary to be familiar with these technologies and adopt a formal methodology to capture the organization's collaborative requirements. However, no methodology currently exists to help an organization determine which technologies and tools would enable and support its specific collaborative requirements. This thesis analyzes collaboration as an organizational phenomenon and a network application, presents ideal collaborative environment characteristics, surveys existing collaborative environments and tools, and proposes a methodology for selecting and building a collaborative environment. This methodology is based on a synthesis of the traditional System Development Life Cycle methodologies used to analyze, design, and implement information systems.</p>				
14. SUBJECT TERMS Collaboration, Groupware, CSCW, Knowledge Management, Collaborative Environment, Development Methodologies			15. NUMBER OF PAGES 141	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL	

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18

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**GROUP COLLABORATION IN ORGANIZATIONS: ARCHITECTURES,
METHODOLOGIES, AND TOOLS**

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Submitted in partial fulfillment of the
requirements for the degrees of

**MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT
AND
MASTER OF SCIENCE IN COMPUTER SCIENCE**

from the

**NAVAL POSTGRADUATE SCHOOL
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ABSTRACT

In a world that is increasingly more connected using networks of all types, collaboration becomes a way to leverage these connections to benefit both individuals and organizations. Currently there are numerous technologies, to support different types of collaboration. In order to make informed decisions, it is necessary to be familiar with these technologies and adopt a formal methodology to capture the organization's collaborative requirements. However, no methodology currently exists to help an organization determine which technologies and tools would enable and support its specific collaborative requirements.

This thesis analyzes collaboration as an organizational phenomenon and a network application, presents ideal collaborative environment characteristics, surveys existing collaborative environments and tools, and proposes a methodology for selecting and building a collaborative environment. This methodology is based on a synthesis of the traditional System Development Life Cycle methodologies used to analyze, design, and implement information systems.

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GLOSSARY

Asynchronous :	At different times
Asynchronous Communication:	Communication between parties that takes place at different time. The message is sent at one time and the reply is provided later.
Collaborative Computing:	The shared computerized work when two or more people are working together, for example, by using screen sharing. See groupware and group support systems.
Computer-Supported Cooperative Work:	CSCW. See collaborative computing
Data:	Discrete, objective facts about events, including numbers, letters, and images without context
Decision Room:	An arrangement for a group DSS in which PCs or terminals are available to some or all participants. The objective is to enhance the decision-making process.
Distributed GSS:	A computerized support system for people who are located in different places, but work as a group on the same task
Group Decision Support System (GDSS):	An interactive, computer-based system that facilitates the solution of unstructured problems by a set of decision makers working together as a group
Group Support Systems (GSS):	Information systems that support the work of groups (communication, decision making)

Groupware:

Several computerized technologies and methods that aim to support the work of people working in groups

Information:

Data with some level of meaning

Knowledge:

A fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of this in the know

Knowledge Management:

The active management of expertise in an organization. It involves collecting, categorizing and disseminating knowledge.

Synchronous:

At the same time.

Synchronous Collaboration:

Collaboration performed at the same time.

ACKNOWLEDGMENTS

I would like to thank Dr. Magdi Kamel and Dr. Gilbert Lundy who shared their time and knowledge in helping me to complete this journey. I would like to give special thanks to Dr. Magdi Kamel for his patience, guidance and tutelage during the completion of this thesis.

My sincerest appreciation, gratitude, admiration, love and thanks go to my wife María de los Angeles, whose endless and infinite love, patience and understanding never faltered and helped me to finish this journey. Finally, I would like to thank my three loving children for inspiring and motivating me every day, and my parents for giving me strong foundations.

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I. INTRODUCTION

A. BACKGROUND

In a world that is increasingly more connected, and networks of all types are part of our IT infrastructure, collaboration becomes a way to leverage these connections to benefit both individuals and organizations. Today, people use these networks to establish contact with others inside or outside their organizations to share information and knowledge, collaborate, discuss, present and work cooperatively to achieve common goals and objectives.

Technology plays a vital role in these efforts, because it enables and supports collaboration. Since there are several collaborative technologies, tools and applications it is difficult to determine which one to use. Different technologies support collaboration in different ways and in various scenarios and situations. Each scenario can be supported by one or more collaborative technologies. In order to make informed decisions for selecting appropriate technologies, it is necessary to be familiar with different technologies, tools, architectures and approaches to collaboration. It is also necessary to adopt a formal methodology to capture the collaborative requirements and determine which are the most appropriate technologies and tools to support these requirements. No methodology currently exists to help an organization determine which technologies and tools would enable and support the specific collaborative requirements of the organization.

B. OBJECTIVES

The overall objective of this thesis is to explore collaboration as an organizational phenomenon, its characteristics, classifications, different approaches to collaboration, supporting technologies, and collaborative tools.

Specifically the thesis develops a methodology for selecting and building a collaborative environment to meet an organization's collaborative needs. This methodology is based on the synthesis of traditional and contemporary System Development Life Cycle (SDLC) methodologies used to analyze, design, and implement information systems.

C. RESEARCH QUESTIONS

The primary research questions addressed by this thesis are:

- Could existing System Development methodologies be adapted to the analysis, design and implementation of collaborative environments?

The secondary research questions are:

- What is collaboration?
- How does collaboration relates to Knowledge Management?
- What is a framework for collaborative work?
- How existing tools help people to perform a collaborative work?
- What are the characteristics of an ideal collaborative environment?

D. METHODOLOGY

First, a literature review on collaboration, its definition and characteristics was completed. Next, existing technologies and standards were studied as well as the different methodologies used to develop information systems. These methodologies were analyzed, synthesized, modified, and adapted to the development of a collaborative environment and a collaborative systems development cycle was proposed. Finally, a comparative analysis of different collaborative tools from vendor information was completed.

E. THESIS OUTLINE

This thesis is organized as follows. Chapter II introduces collaboration as an important activity in modern organizations. It presents several definitions of collaboration and identifies their common characteristics. These definitions are complemented with examples of different types of collaboration. A framework for collaboration, based on time and space domain is then presented. The chapter concludes by relating collaboration with the emerging discipline of Knowledge Management.

Chapter III discusses the role of technology as an enabler. The different collaborative technologies are presented and classified according to the time/space framework. The chapter describes the different architectures used in collaborative

environments. These include client/server and peer-to-peer architectures. Protocols and standards used in the different technologies and their importance are also presented. The chapter concludes with the challenges and trends that face collaborative technologies today and the future.

Chapter IV describes the characteristics of an ideal collaborative environment. Next, it describes different methodologies to develop information systems and applications and synthesizes them to propose a development methodology for collaboration systems. A prototype expert system is also developed to help users determine which collaborative technologies are appropriate for an organization's specific set of collaborative requirements

Chapter V presents a comparative analysis of some of the existing collaborative tools in the market today. Products from Microsoft, IBM/Lotus, Sun Microsystems and Cybozu were chosen for the analysis based on their popularity, market share, and relevance to DOD.

Chapter VI summarizes the main points of the thesis and presents general conclusions and lessons learned.

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II. COLLABORATION OVERVIEW

James Watson, who won a Nobel Prize with Francis Crick for their discovery of the double helix, puts it simply: “nothing new that is really interesting comes without collaboration.” (Schrage 1995).

A professor from a well-known Eastern university who went to MIT to present a few of her most recent findings on how work groups make decisions. In passing, she mentioned her research with the university students and revealed that collaborative efforts to solve problems were consistently less successful than individual efforts. This created a bit of a stir. Then, the professor continued, “My colleague, Professor Smith, and I will shortly publish a paper that examines the implications of those findings.” (Schrage 1995). Such an irony confirms that collaboration is one of the most poorly understood and least appreciated of human behaviors. It also happens to be one of the most important.

These two stories illustrate how important collaboration is and serve as an introduction and reason for studying what collaboration really is in more detail. What is meant by talking about collaboration? Who is involved? When and where is it used? Why do people in organizations collaborate? What are its benefits and drawbacks? How is technology related to this activity? How is management affected by collaboration?

This chapter will attempt to provide answers to these questions. It begins with a definition of collaboration and distinguishes it from communication. Next, the reasons why people and organizations want to collaborate are explored. Then, the concept of Knowledge Management as it relates to collaboration is presented. The chapter concludes with a framework for collaborative work.

A. COLLABORATION BASICS

1. Why are We Interested in Collaboration?

Before trying to define collaboration, it is necessary to explain why there should be an interest in studying and writing about collaboration. Understanding collaboration is important for a number of reasons (Huxham 1996):

- Collaboration is occurring
- Collaboration is valuable
- Collaboration is difficult

(a) Collaboration is Occurring. Collaboration can be seen increasingly in modern organizations. People must work together to solve complex problems, which of course necessitates the formation of workgroups. Strategic alliances, joint ventures, public-private partnerships, coordinated services, community development, are popular approaches that require collaboration between people and between organizations. Collaboration is applicable to any type of organization in the private or public sectors. Cross-sector collaboration is also common. Since the interested parties see some benefit in collaborating, a great deal of collaboration is voluntary. However, in certain instances, collaboration is mandated or motivated by authorities through the issuance of laws or incentives to collaborate. This situation occurs in multisector collaboration, more so than group collaboration.

(b) Collaboration is Valuable. Collaboration is certainly a way to achieve things that would be difficult or impossible for people or an organization to do on its own. This reason alone makes it valuable as it is motivated by self-interest. This self-interest motivation does not imply that it is at the expense of others. Rather, an organization or person may initiate or participate in a collaborative effort because it can achieve something that cannot be achieved in any other way. For example, a company might seek to collaborate with another possessing local knowledge of a market it wishes to penetrate. Another motivation, called the moral imperative, applies particularly to organizations in order to tackle major social problems. Important social problems, such as poverty, conflict and crime, are so big and complicated that no single organization can tackle them by itself. Collaboration is thus essential in order to have any hope of solving them. This type of collaboration is out of the scope of thesis and therefore will not be discussed further.

(c) Collaboration is Difficult. Working with others is not easy and could be extremely complicated. Several social issues make collaboration

particularly difficult and these must be considered and managed adequately when implementing collaboration. Examples of difficulties follow.

- Differences in goals, language, procedures, culture, and perceived power. Collaboration implies at least two participants, usually with different goals about what they want. Therefore, the reasons for collaborating might differ for each of the participants, even if they agree that they want to collaborate. This requires a process of finding a way to satisfy the goals enough in order to allow collaboration. This issue is not only exacerbated by different languages, which does not only include spoken languages, but by procedures and an organization's culture which can make collaboration very difficult since collaboration will usually require a certain amount of time to adjust the process and reach a consensus, understanding and agreements.
- Time is required to create relationships between the people participating directly in the collaborative effort. Also, participants expend time and energy when going to the parent organizations to give and receive feedback.
- Time is required for all logistics support. Everything must be planned and coordinated which is time consuming.

2. What is Collaboration?

Collaboration can thus be simply defined as “working in association with others for some form of mutual benefit”. A more formal definition is that collaboration involves two or more people working together in real-time, or in a "store-and-forward" mode. Applications will enable a group of people to collaborate in real-time over the network using shared screens, shared whiteboards, and video conferencing. Collaboration can range from two people reviewing a slide set on-line to a conference of doctors at different locations sharing patient files and discussing treatment options (DON KCO Toolkit).

Collaboration can also be defined as the interaction among two or more individuals and can encompass a variety of behaviors, including communication, information sharing, coordination, cooperation, problem solving and negotiation.

All the above definitions have some aspects in common.

- Two or more individuals
- They have common goals or objectives
- They cannot do the task by themselves

- There is interaction between the participants

Any task that meets the above criteria can be interpreted or defined as collaboration.

Collaboration is temporary. It is designed for a specific purpose. Once that purpose is accomplished, collaboration frequently dissolves. This does not mean that the participants cannot or will not collaborate again. Since the common problem was solved, there is no longer any need to interact on that issue. If another problem or question arises, the same people can collaborate to deal with this new problem, but this collaborative effort will be different, and the method of collaboration used might also be different. Also, the number of people collaborating on this new problem might increase or decrease.

3. Why People Collaborate?

People do not collaborate because they are mandated to do so. At the very heart of collaboration, a desire or need exists to:

- solve a problem
- create or discover something

There is however a set of constraints that include:

- expertise – one person alone does not know enough to deal with the situation
- time – collaboration requires time
- money – collaborative projects require budget
- conventional wisdom – collaboration is affected by the prejudices of the day

People collaborate out of necessity in order to solve or accomplish their tasks, and because they cannot do it by themselves due to the above-mentioned constraints. Someone else is needed who possesses the knowledge, and those individuals probably are facing the same problem or dilemma.

The success of a collaborative effort can be measured by its results. The collaborators either solve the problem or they have failed.

4. How is Collaboration Achieved?

Collaboration is not an isolated activity in organizations. It deals with work performed by people to support the objectives of the organization. Thus, in order to achieve collaboration, people, work, groups and objectives are required ingredients.

Work does not exist in a vacuum and neither does the worker who must accomplish it. Workers perform their jobs in the midst of, and often in conjunction with, other people. Different types of work require different forms and levels of cooperation, including individual, group, and team collaboration. Each level of cooperation possesses unique technological support requirements.

The different levels of work must be defined and distinguished before technology can appropriately support them (Coover and Foster, 2001).

a. Individual Work

Individual work includes the activities that a single person performs while pursuing individual, group, team, or organizational objectives. Individual work is a critical component of collaboration because the modus operandi of individuals substantially affects the contributions made to collaborative efforts. Individual efforts contribute to organizational functioning both directly and indirectly.

b. Group Work

Groups and teams are two additional components in organizations. A group is a collective unit of two or more people with a broad common goal. Group members interact with each other, yet their tasks are typically independent. People in groups may work at the same time in a common physical location or they may work at different times or in separate locations. Time and space do not oblige group membership. Two characteristics, interaction and shared goals, distinguish a group from a simple collection of people. For instance, the faculty within a university department forms a group, because they interact with each other periodically. They share a common goal of educating students in a particular field of study. Conversely, students within a university do not form a group because they do not all interact with one another and they do not all share the same goal.

Work group members have much to gain from one another, and the extent of their collaboration will depend on how well organizational technology facilitates the communication and informal interactions. Good collaborative technologies allow group members to share information and capitalize on one another's knowledge and skills.

c. Teamwork

Individuals working alone or within groups cannot effectively accomplish some types of work. Rather, many tasks require or benefit from a team effort. A team is a set of two or more individuals who work interdependently and adaptively toward an organizational objective. Many organizations, realizing the benefits of teamwork, are currently reengineering work around a team's tasks rather than around an individual's task. As a result, teams are now used extensively in numerous settings, including factories, hospitals, schools, stores, the military, and other branches of the government. Groups are differentiated from teams in terms of task interdependence. Whereas groups are collective units with little or no interdependence among individuals, teams have a high degree of interdependence, which necessitates interaction among members.

Like groups, teams are not necessarily confined to common geographic locations and time schedules. Teammates can work interdependently from separate locations, and they can also work during different times of the day. A few examples of teamwork include airline crews consisting of pilots, copilots, flight attendants, and others, as well as new-product development teams consisting of various salespeople and service technicians.

In order for any of the organization's objectives to be met, multiple individuals, groups and teams often perform a wide variety of functions. Broad organizational objectives will be facilitated to the extent that structural technology supports the functioning of diverse entities working at multiple levels of collaboration (individuals, groups, and teams) to achieve common overarching goals.

Organization is thus achieved by forming groups and teams, which through the individual work of its members, the organizational objectives and the supporting technology form the framework of a collaborative environment. Groups and teams can be permanent or specifically formed for a particular need. Workers might

collaborate without knowing it, instinctively, or when mandated by upper management (Coover and Foster, 2001).

5. Examples and Types of Collaboration

Collaboration occurs in almost any field. This section presents examples that illustrate how collaboration is used in a number of fields.

- During surgery, the situation begins to deteriorate for no apparent reason. The patient starts to show uncommon symptoms and vital signs change. The anesthesiologist and the surgeon agree to increase the flow of oxygen, but it does not work. They are facing a real problem where the consequences might be fatal. They discuss whether to continue, alter, or finish the procedure.
- On an airplane, a problem occurs in one of the engines. Lights start to flicker, pressure levels drop, and the temperature increases. Again, the pilot, copilot, and engineers work together to determine what is happening and decide what to do.
- A group of high rank military officers discuss how to proceed with war operations after recent events in which they lost some airplanes, but at the same time gain terrain on the ground, or the same military officers analyze the results and learn some lessons from an exercise they have just completed.
- Members of a team are writing a document that summarizes their findings on a specific subject. With collaborative editing technology, they can contribute to the final document from different places and at different times while preserving changes or comments made by any of the members.
- A group of engineers need to discuss the design of a very specific part of an airplane. Through collaboration they can share points of view and opinions about how the piece should be modified to reduce weight and size. They can share technical drawings, comments and proposals on line to finally decide what has to be done and why.

All of these teams have a genuine problem and limited time in which to deal with it. There may be no right answer, but there are certainly wrong answers, and some of them can be tragic.

Several types or levels of collaboration can be identified (Coleman, 2002):

- **Messaging and Calendaring:** The most fundamental form of exchanging information in today's Internet-centric environment. Used by organizations to share data internally and externally. It is also the most common way to coordinate activities and to hold informal contacts.

- **Project management:** In this type of collaboration, project managers and team members collaborate in planning, executing, controlling a specific project. All the different phases of a project require high interaction of several individuals, where some of them might not even be part of the project team. Because projects usually are interdisciplinary, involve different working places, require lots of activities and documents to be managed, collaboration is something that is absolutely needed. This type of collaboration is characterized by high interaction, severe control systems, and high volume of documents to be stored, shared and presented.
- **Data management:** In this type of collaboration, information is controlled down to the file level and, as in project management, includes revision tracking, but at this point sophisticated access controls and file dependencies are tracked and managed. This type of collaboration has wide applications in organizations being the typical documents repositories where members of the organization access to documents that are stored and shared for specific or general use.
- **Data access:** This type of collaboration allows users to access data, either with read only or with full access (read-write) privileges. The difference lies in the ability to make changes. While in read-only there is no chance to make modifications, with full access changes can be performed. Users can launch applications across the Internet and interact directly with data in its native format. This type of collaboration can be used by researchers and professionals to discuss different topics, comment and discuss documents.
- **Real time design/editing:** In this type of collaboration, multiple users can launch applications and share them with others in real time, allowing others to access the control of the application and make changes in real time. Typical uses are real time document editing and on line design, where experts collaborate from different places at the same time in the design of a part or in the writing of a document or report that involves different people.

A more general classification of levels of collaboration is the following:

- **Level 1:** individuals operate independently and interact to accommodate their own specific needs by passing documents back and forth and sharing information, but not as a part of a working group or team
- **Level 2:** a group of individuals exchange information as part of a community of interest, but not to achieve a common goal
- **Level 3:** collaborators operate as a team to achieve a common purpose by working together and gaining new insights

B. FRAMEWORK FOR COLLABORATION

1. Concept of Shared Space

Often collaboration is confused with communication. In order to have collaboration, communication between the participants must exist. However, just having communication does not imply that there is collaboration.

When people have a conversation they are communicating among themselves. Conversations, whether time delayed or not, are ephemeral as the words vanish the instant they are spoken. Even when taking notes, it is rarely possible, if ever, to obtain a perfect transcript because of the inevitable discrepancies between what is said and what is heard. People generally respond to what has just been said, not to something said several minutes earlier. Conversations do not have memories; only their participants do.

In most conversations, people take turns exchanging information, not sharing it. In most conversations, the absence of memory means a useful phrase or expression can be distorted or lost. Michael Schrage states that people frequently rely on a transactional model of communication, which is depicted in Figure 1.

Sender/Receiver ----- Conversation ----- Receiver/Sender

Figure 1. Transactional Model of Communication (From Schrage, 1995).

The collaborative model is quite different, as seen in Figure 2. There is a shared space that adds a new dimension to a conversation; a dimension embracing symbolic representation, manipulation, and memory. Participants need to have equal access to this shared space in order to have a real and effective collaboration.

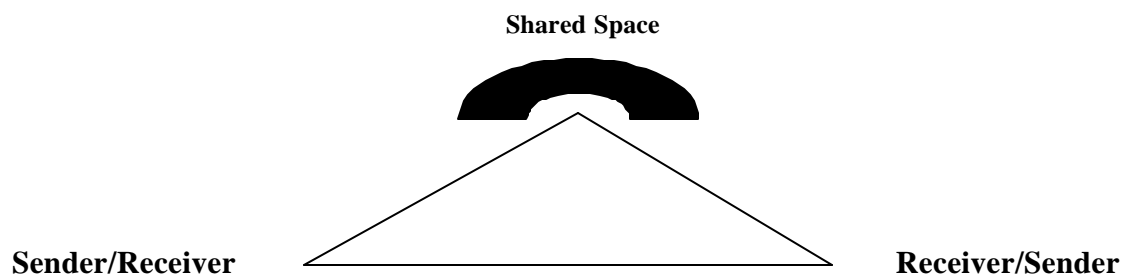


Figure 2. Collaborative Model (From: Schrage, 1995).

In this model participants can communicate with one another directly or through shared space. Symbols, ideas, processes, sketches, music, numbers, and words can be put in this shared space to be expanded, organized, altered, merged, clarified, and otherwise manipulated to build new meanings. It takes shared space to create shared understanding (Schrage, 1995). Conversations are vital, but are not enough.

Wherever there is collaboration, a shared space exists. Either the collaboration is to discover something not known, or to create something new, or to solve a problem that bothers people. These spaces are seen in the discoveries of scientists, are heard in the songs created by authors and composers, and are seen in the work that actors, designers and directors perform on stage.

The shared space can be manipulated, modified or adjusted according to the circumstances and players. They are divorced from time or distance or both. A blackboard can easily be worked on asynchronously, with collaborators leaving notes and annotations for one another at all hours of the day and night. It can also be worked on synchronously, with collaborators making a joint effort. Similarly, a fax machine and a telephone can eliminate distance for collaborators. Successful shared spaces create the aura of copresence in that they make collaborators feel like they are together, even if they are not.

In this shared space, it is easy to play. Formal protocols may exist, but they should not be rigidly enforced. What is desired is a process of creation and innovation and playing in this shared space to allow for the two essential ingredients of curiosity and serendipity. The shared space thus becomes, in a frame of reference, a medium as much as a collaborative tool. It becomes a collaborative environment.

On a final note, the linguistic root of communication is “communicare”, which does not mean “to communicate”, but “to share”. Collaboration takes communication back to its roots (Schrage, 1995).

2. Time and Space Domain

In the previous definitions of collaboration, there was no specific mention of time or space, but collaboration must deal with these dimensions. People collaborate with others either in the same place or in different places. Similarly collaboration can occur at

the same time or at different times. A 2 x 2, matrix as in Figure 3 which is based in Dr. Robert Johansen's Time/Space domain, can best represent this environment.

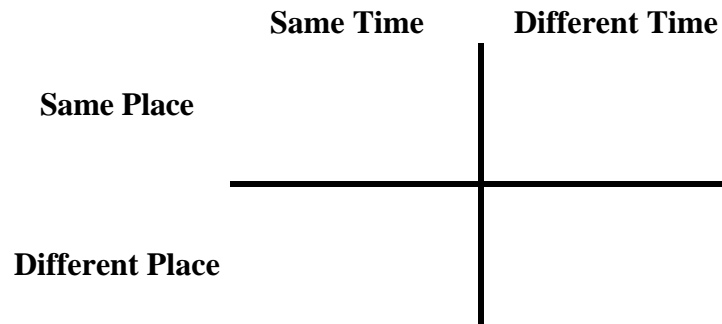


Figure 3. Time and Space Domain.

The results of collaboration in the different quadrants of the matrix will be different and the technology used will also be different. Moreover, the same representation of time/space is used to classify the different collaborative tools in subsequent chapters. The choice of a quadrant is dependent on the situation, available media, urgency of the issue, location of the participants, and other constraints.

The time domain distinguishes messages that are sent at a certain time and received almost immediately as synchronous communication/collaboration, and messages that are received at a different time than sent as asynchronous communication/collaboration. Similarly, participants can be in the same place collaborating, or they can be at different locations.

Thus, there are four possible combinations of time and space that define four possible ways to collaborate

- **Same time/same place:** the participants meet face to face in one place and at the same time. An example is a decision room.
- **Same time/different place:** this setting refers to a meeting where the participants are in different places, but they communicate at the same time. Examples of such situations are video teleconferencing, a conference telephone call or an Internet chat forum.
- **Different time/same place:** this setting can occur when people work in shifts. The first shift leaves messages for the second shift

- **Different time/different space:** participants are in different places and they send or receive messages at different times

Several technologies can be used to support the four cells and will be presented in further chapters.

C. COLLABORATION AND KNOWLEDGE MANAGEMENT (KM)

One of the newest thoughts in management today is Knowledge Management. Today almost every big organization is implementing or considering implementing some type of Knowledge Management initiative. Knowledge Management is highly related to collaboration, since collaboration is part of its processes. In the following sections we discuss what is KM and the relationship between KM and collaboration.

1. What is KM?

The terms data, information, and knowledge are often used interchangeably, but have significant and different meanings.

Data is discrete, objective facts about events, including numbers, letters, and images without context. Information is data with some level of meaning. It is usually presented to describe a situation or condition and therefore has added value over data (DON KCO Toolkit).

Knowledge goes one step further and can be defined as a fluid mix of framed experiences, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories, but also in organizational routines, processes, practices, and norms. (Davenport and Prusak, 1998).

Knowledge has become one of the most important assets and competitive advantage of an organization, so it needs to be managed appropriately to leverage its value across the organization. Neither the organization's nor the individual's knowledge is sufficient; they have to be combined to form a knowledge base. This knowledge base allows organization gain sustained competitive advantage.

Knowledge Management can also be defined as the systematic process of finding, selecting, organizing, distilling and presenting information in a way that improves an employee's comprehension in a specific area of interest. KM helps an organization to gain insight and understanding from its own experience. Specific knowledge management activities help focus the organization on acquiring, storing and utilizing knowledge for such things as problem solving, dynamic learning, strategic planning and decision making. It also protects intellectual assets from decay, adds to firm intelligence and provides increased flexibility (Graduate School of Business, University of Texas at Austin, 1998).

Several stages or steps are identified in a Knowledge Management process. They are knowledge creation, codification, sharing and distribution (Davenport and Prusak, 1998). Other authors like Newman and Conrad (1999) describe the process of knowledge management as creation, retention, transfer and utilization of knowledge. Knowledge has to be created somehow, shared within the organization and later on distributed and utilized by all pertinent members of the organization.

2. Relationship Between Knowledge Management and Collaboration

How are Knowledge Management and Collaboration related? In an October 2001 on-line KM World magazine poll, a question asked if enterprise knowledge could be managed effectively without robust collaboration. Eighty six percent of the respondents said absolutely not, while fourteen percent said that collaboration is overrated and knowledge could be managed without robust collaboration.

This result, even though it is not from a scientific or academic study, shows that people who manage knowledge in companies today feel that collaboration is absolutely necessary in order to successfully manage knowledge and leverage its value. This need is the connection between knowledge management and collaboration. In order to have good knowledge management, collaboration must exist inside the organization.

Figure 4 (from ICASIT) describes the relationship between Knowledge Management (KM) and collaboration. As it can be seen, for each one of the knowledge process activities there are Information Management Systems and Knowledge

Management Applications that support those functions. In the knowledge creation process highly skilled workers create new knowledge and try to integrate it into the organization. In knowledge codification, Artificial Intelligence (AI) Systems, Expert Systems and others provide organizations and managers the codified knowledge in order to be reused by other members and therefore to expand the knowledge base. In knowledge sharing, collaboration tools allow members to share the generated knowledge across the organization. These tools allow people in organizations to collaborate, coordinate and share knowledge. Finally, the knowledge distribution is achieved by automation systems designed to disseminate and coordinate the flow of the information throughout the organization.

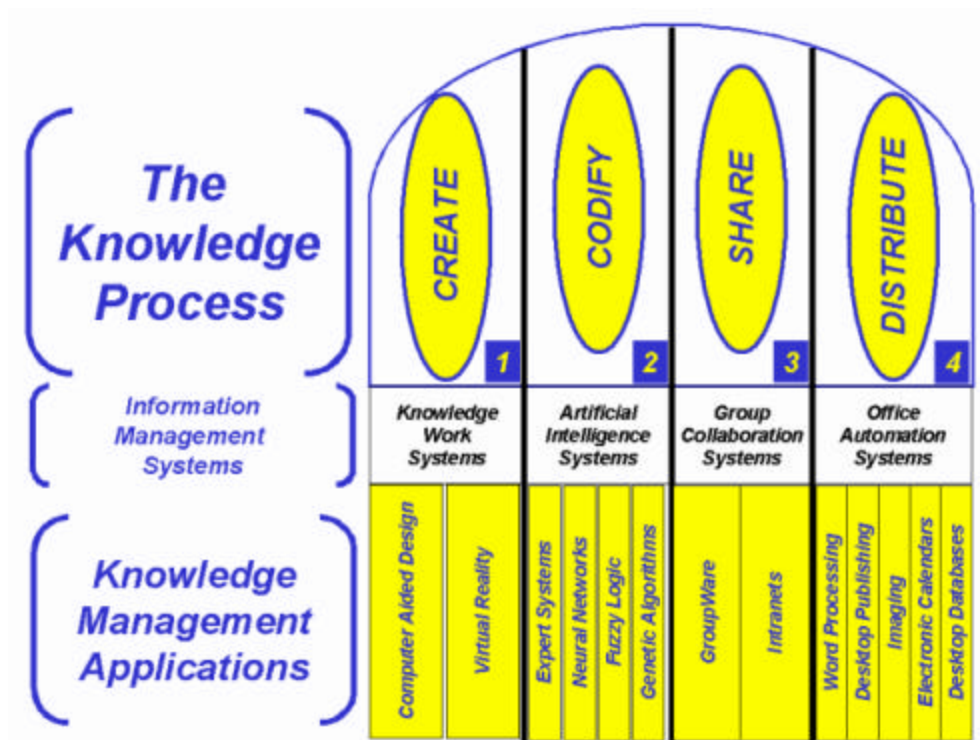


Figure 4. KM tools and the Knowledge Process (From: ICASIT).

Figure 4 highlights the importance of knowledge sharing in the knowledge management process. No matter how valuable the knowledge created inside the organization is, if it cannot be shared and disseminated throughout the organization, it will be lost. If workers don't have means to share the knowledge, knowledge will be

something limited to a few members of the organization, and the main goals of KM, will be not achieved.

Knowledge management has evolved to the point where it is no longer just another corporate buzzword. Many organizations are actually implementing knowledge management strategies and infrastructures that provide them with real benefits in terms of information sharing and streamlining processes. By offering sound collaborative capabilities, a knowledge management system can provide the platform for helping users share documents and project tasks, find outside experts when needed, and know the exact status of a project, even when the project involves multiple employees or even people outside the organization.

The following chapter analyzes the different technologies that enable and allow collaboration in organizations.

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III. COLLABORATION TECHNOLOGIES

This chapter presents and discusses the role of technology in collaborative environments and the different types of technologies that support collaboration. A classification and a brief explanation of the most important technologies is given though the focus is mainly on their use, and advantages and disadvantages in collaborative efforts. A brief description of the most popular standards used in collaboration is also presented. The chapter concludes with some of the current challenges and trends of collaborative technologies.

A. THE ROLE OF TECHNOLOGY IN COLLABORATION

While technology plays a critical role in terms of how organizations collaborate, technology is, in general, an enabler of the interpersonal interactions that comprise collaboration. Economics, organization's culture and internal politics also significantly impact the efficacy of such implementations. So, technology is not the only factor to achieve efficient and effective collaboration.

The role that technology plays in collaborative work is very important. Technology enables the implementation of management and social concepts of collaboration in a collaborative environment. Today, most collaboration efforts are implemented using some kind of technology. New collaboration ideas and processes have to be supported by some type of technology, and sometimes it is the technology that derives new forms of collaboration.

Collaborative computing is known by a number of terms including groupware, group support systems (GSS), and computer-supported cooperative work (CSCW), but these terms are however not completely interchangeable. For example, groupware is defined as the set of technologies available to support collaboration through the use of computers, while CSCW is described as the field of study that examines the impact of groupware on group behavior and performance. Another term used to describe collaboration is computer-mediated communications referring to communication among individuals conducted through the use of computers (Mitre Corporation, 2000).

For effective collaboration, the technology must support the dynamic world of work be it individual, group and/or teamwork, as well as each level of collaboration. All the hardware, software, protocols and standards must support and allow people to collaborate under their specific conditions and environment. Each group of people and each organization have different needs, and even the same people might have different requirements in a different situation. Collaborative technology must support all these situations. As a result many collaborative technologies exist. Each type of collaboration has a unique set of technological requirements. Therefore, it is important to make distinctions between the levels of collaboration during collaboration research and practice (Coover and Foster, 2001).

In analyzing and deciding which collaborative technology/tools to implement or deploy, the level of collaboration must be clearly defined. The role of technology is to support any of these levels as best possible.

B. FRAMEWORK FOR COLLABORATION TECHNOLOGIES

Johansen's Time/Space framework presented in Chapter II is a common and popular way to classify collaborative technologies. The most generic representation of technologies in this framework is shown in Figure 5.

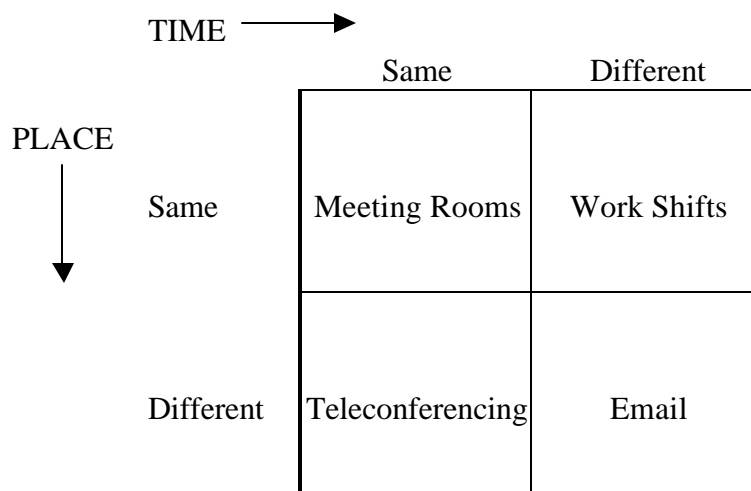


Figure 5. Generic Representation of Technologies in Time/Space Framework (From: Mitre).

Collaboration in the same place and at the same time is held in meeting rooms, which basically are face-to-face meetings. Collaborators can use computers to help and improve their collaboration. This type of collaboration can be accomplished using a Group Decision Support Systems, a presentation, or a whiteboard. The primary characteristic of this type of collaboration is immediacy.

Collaborating in the same place, but at a different time is very well described and understood as work shifts. When the time/shift of people working in a location ends, they leave messages, information, tasks, comments or instructions for the other group of collaborators to continue or complement their work, or even start a new but related task. Document sharing is a typical application in which kiosks are used. Kiosk users can interact with some data and can act upon available information as well as provide feedback to kiosk developers. Data owners collaborate in non-real time to improve the effectiveness of the information resource. In some companies, especially those with flexible time, commission sales forces, and casual vended services, this mode may be the only place where a mobile workforce can actually connect with co-workers.

For collaboration in different places, a public, for example the Internet, or private network is absolutely necessary. Whether it is at the same or different times, collaborators are separated and therefore need to be connected in some manner. Computer networks (LAN, WAN or MAN), and/or Intranets and/or the Internet provide this crucial communication link. Telecommunication technologies make it possible to project those dimensions that are most relevant to the decision-making process and information sharing. These personal dimensions can effectively and relatively economically transcend distance.

A more detailed representation of the framework showing some specific computing support technologies can be seen in Figure 6.

	Same Time	Different Time
Same Place	GSS in a Decision Room Web-based GSS Multimedia Presentation Systems Whiteboard Document sharing	GSS in a Decision Room Web-based GSS Workflow management system Document sharing Email, Vmail
Different Place	Web-based GSS Whiteboard Document sharing Videoconferencing Audioconferencing Computer conferencing Email, Vmail	Web-based GSS Whiteboard Email, Vmail Workflow management system Document sharing Computer conferencing with memory

Decision Support Systems and Intelligent Systems, Efraim Turban and Jay E. Aronson, 6th edition.
Copyright 2001, Prentice Hall, Upper Saddle River, NJ

Figure 6. Computing Support Technologies.

There is also another, and less common, way to classify collaborative technologies based on the level of interactivity and impression in the collaboration. Interactivity means the degree of activity between participants in the collaborative effort, and impression states for the level of impact that produces the collaboration in the participants. These two factors combined are related to a specific goal to be achieved. The resulting 2x2 matrix can also be used by identifying the desired goal and determining the different levels of interactivity and impression required to achieve that goal. Figure 7 depicts the matrix of this approach and related tools.

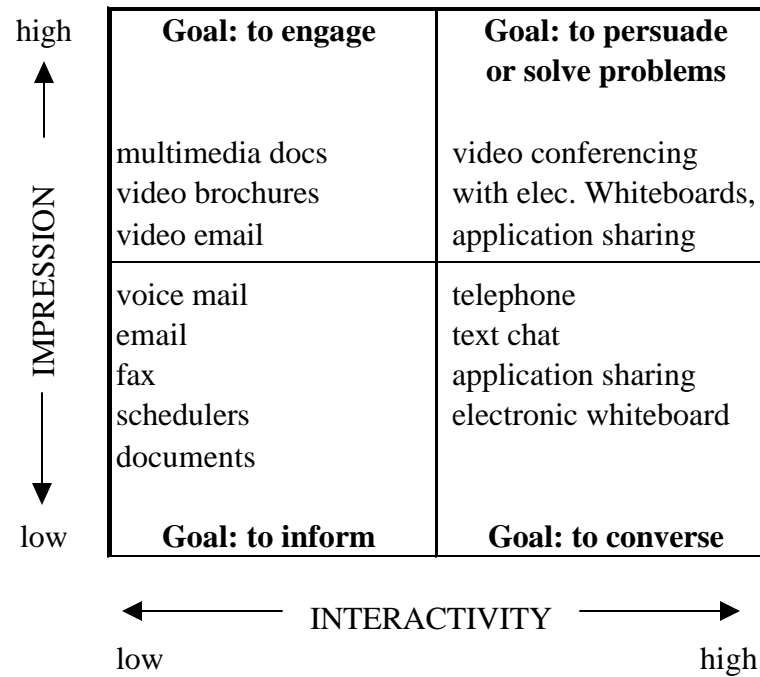


Figure 7. Interactivity and Impression Matrix for Collaborative Support (From: Goodyear, 2000).

C. ASYNCHRONOUS AND SYNCHRONOUS COLLABORATION

Since the most popular way to classify collaboration technologies is the time/space domain, this section presents the existing technologies for synchronous and asynchronous collaboration. Synchronous collaboration is performed at the same time no matter the place where it occurs. Conversely, asynchronous collaboration occurs when people collaborate at different times.

1. Asynchronous Collaboration

Asynchronous collaboration allows data to be sent as soon as senders are ready to send it, regardless of whether the recipients are ready to receive it. Asynchronous collaboration includes email with attachments, threaded discussion lists, bulletin boards, and persistent electronic “rooms” where members can store and access common documents and files at their convenience. Asynchronous capabilities are:

- Bulletin Board: central electronic repository that allows users to post information for members to share

- E-Mail: a network service that allows users to send, create, receive, view, store, and forward messages
- People Locator: ability to find another user's name or identification to send email
- Group Calendars: ability to share calendar information between different users
- Threaded Discussions: asynchronous postings to which people can link responses
- Virtual persistent Workspace (Virtual room): a permanent, networked environment where a group of users share expertise and contribute to solving problems via virtual teaming activities

A benefit of asynchronous collaboration is that users work at their own space and on their own schedule. The disadvantages are that the information is not filtered, and users must find solutions to any problem they face.

In the following sections, the most important asynchronous tools will be described including the main issues and concern of using these tools in collaborative environments.

a. Email

Electronic mail is as important to a network as its print and file services. Email has become a critical component in any collaborative environment whether in a big or a small organization. Electronic mail can be defined as the transmission of text from one computer to another. Audio and video files can also be transmitted, but the majority of email messages are text only.

The term "email" is sometimes confused with the term "messaging", but the two terms are not synonymous. Email is an application, which performs the task of creating and reading electronic mail messages. Messaging is the electronic infrastructure where email and other applications can reside. Email, along with scheduling, workflow, voice, and fax among others, uses the messaging infrastructure for delivery (Wong, 1995).

(1) POP Mail. POP (Post Office Protocol) mail is normally used in conjunction with 3rd party email management software like Outlook or Eudora on the client computers. To receive mail with a POP mail account, end users connect to a

shared mail server and then download all the new mail to their computer. Thereafter, the 3rd party email software located on the user's client computer enables them to read, send and perform a host of email management functions. The user's computer stores all emails received locally. POP mail provides a store-and-forward service, moving mail on demand normally from a mail server to a single local client computer. Once an email is delivered to the client software, the message is typically deleted from the POP server. POP is for people who will be managing their email from one computer only as the settings are local as is mail management.

(2) Web-based Mail. Web-based email is also known as Web Mail or browser-based email, because it uses a browser and the Internet as tools to access the email account. Web-based email possesses virtually all the functionality of other types of email and allows access from anywhere in the world. Web Mail is characterized by its mobility and ease of use because configuration is not necessary. Web-based email has all the standard functionality associated with POP mail, and allows users to:

- Send, receive, forward and reply to email messages
- Send and receive attachments
- Create and manage folders
- Create and manage contacts
- Check mail from other POP email accounts
- Customize signatures, identities and other preferences
- Edit Passwords
- Utilize auto-forwarding and vacation auto-responses

Web-based email is for the people on-the-go who need to manage their email from different computers. The settings are remote, as is the mail management.

(3) IMAP. IMAP (Internet Message Access Protocol) combines features of Web-based mail and POP mail, and allows users to access email from their local server. IMAP is more useful for businesses that have their own servers. IMAP is a client/server protocol in which the server receives and stores messages while the client computer displays the header and sender of the email. This system allows the users to decide whether or not they would like to download the message. Even when

downloaded, messages remain on the server. Users can delete messages, manipulate folders and accounts and manage other features on the server. Email stored on an IMAP server can be manipulated from many computers such as home desktops, office workstations and laptops. IMAP provides mobility and convenience, eliminating the need to transfer messages or files back and forth between different computers. IMAP is much more flexible than POP, but requires a little more understanding of the email system. The settings are local and mail management is remote.

Table 1 summarizes the characteristics of these three types of email systems.

WEB	POP	IMAP
<ul style="list-style-type: none"> • No software configuration • Functional, feature rich and mobile • Branding abilities • Any computer w/Internet and browser 	<ul style="list-style-type: none"> • Less complex protocol than IMAP • Less complex to implement than IMAP • More client software currently available • Static usability – single computer 	<ul style="list-style-type: none"> • Remote feature manipulation • Multiple folder support • Online performance optimization • More mobile – synchronizes multiple computers

Table 1. Different Types of E-Mail (From: Entergroup, 2002).

(4) Shell Accounts. Shell account email is available on older computer users using the Telnet Protocol. A main advantage of shell account access is that it can be done anywhere, any time and on any computer, regardless of what software is used on the computer. Settings are remote and mail management is remote.

An application of email technologies is the Mailing list servers (also called listservs, list processors, and distribution lists), which are programs allowing an administrator to create lists of email addresses and attach them to a single email address. All messages that are emailed to the list are distributed to all subscribers, sometimes by a "moderator", who reads them first (in a "moderated list"), and sometimes automatically (in an "unmoderated list"). Some mailing list servers require an administrator to add people to the list. In others, anyone who wishes can automatically subscribe or un-subscribe by sending an email message to the program, which resides on a server. Mailing list server programs can provide some security by allowing only

authorized users to post to the list or by using a moderator to approve messages before they are posted to the list. Mailing list servers are an efficient way of sending email to large and/or specific groups and are ideal for disseminating timely information, such as announcements of conferences, pointers to new Web sites of interest, and descriptions of print resources. Anyone on the list can be a source of information. Mailing list servers are well-suited to groups of users who regularly use email and who need to receive information in a timely manner. They are less effective for extended or lengthy discussions since participants may not be able to remember all the previous entries when they respond to a particular item. Another disadvantage of mailing lists is that they can be inconvenient for recipients by filling their email in-boxes with unwanted messages.

(5) Email Directory Service. LDAP (Lightweight Directory Access Protocol) is metaphorically the White Pages of the Internet. LDAP is the part of the TCP/IP protocol which enables users to perform searches for other users within a domain. Users can search such criteria as name, phone number, and workgroup membership information.

If a domain of a Web-based email site is LDAP provisioned, an end user can use the LDAP client to update his or her own directory entries. This tool also allows domain administrators to update, add and delete entries for their domain.

To access LDAP, the end user can use various 3rd party email software, such as Outlook and Outlook Express. Since desktop software can vary in the way it supports LDAP authentication, not all LDAP clients are compatible.

(6) Pros and Cons of Email. The biggest advantage of email is that it is the lowest common denominator of Internet communication and therefore will reach more people than any other medium. Like other forms of online communication, and because of the lack of vocal inflection, gestures, and shared environment, email is not as rich a communication method as a face-to-face conversation.

A very common concern with email is that hackers use it to spread viruses, and hoaxes. Another concern is unsolicited bulk email, also known as Spam. Even though hackers might not directly affect a collaborative session, it does indirectly by interfering and damaging the organization's IT infrastructure.

A related concern is what Gail Work, President of Work Systems, calls the “cc habit”, which results in receiving numerous email messages a day that are of little relevance or value. Long “cc” lists may be used to assure, in the sender’s mind, that all the appropriate parties are involved in a topic. However, in many organizations, when people get busy, they just delete “cc” mail and do not read it. The longer the cc list, the more people assume that someone else will take care of the issue.

In collaborative environments with an intense exchange of documents and files, a backlog of copies derived from the same document is created. The email attachment can result in an inundation of documents whose relationship and management will be left to the user to sort out. Enclosures and attachments are a good mechanism for enriching a simple text message, but if these enclosures are used to collaborate in the development and evolution of a document by several authors, then a document management system is a better tool. These systems can also benefit from the various notification and forwarding capabilities provided by email systems.

Emails must be checked against viruses, filtered, sorted, managed and filed by sender, topic, date, or any other criteria defined by the user. In addition, if attachments are included, recipients must have the appropriate software on their local computers to be able to "read" the attachments.

b. Discussion Groups

Discussion groups are focused around a topic or a specific activity, goal, or project. Groups may be limited to members or open to the public. Some groups are open-ended and not moderated, allowing users to solicit information from each other. Other, more structured groups may use a moderator to guide the discussion by filtering and posing questions and/or making comments, suggestions, and connections. In Web-based discussion groups, messages can include links to Web pages and can be referenced by Web pages.

Discussion groups are also known as forums, newsgroups, or conferences where collaborators can converse and build relationships with their colleagues, outside consultants, subject matter experts, and other specialists.

People might want to collaborate through discussion groups, because they want to solicit information or just make a contact. Discussions in these forums are generally short. Users post messages asking for information. The conversation is usually not moderated and the shelf life is typically limited to a brief set of interactions. These groups may or may not be restricted to certain users. In other occasions, users use discussion groups to talk about a specific topic or they want to accomplish a task. In this last case, moderation is more structured than in previous cases.

USENET newsgroups are commonly used to solicit information from members with similar interests. These discussion groups are organized around common interests. Newsgroup names are arranged topically and hierarchically, so that the first part of the name indicates a general category. "Mainstream" categories include comp, misc, news, rec, soc, sci, and talk, the "alt" category is for topics "alternative" to the mainstream. The second part specifies a subgroup, for example, "alt.health" deals with health issues.

The most common way to join a discussion group is via a mailing list server. This is a program allowing an administrator to create a mailing list of addresses and attach the list to a single email address. When users send mail to the mailing list server address, it is distributed to all members on the list. There are also Web-based tools that automatically archive discussion messages and allow users to sort, organize, and capture ideas so they can reflect upon their discussion later. Some other common Web-based technologies that support discussions are topic-based discussion systems, threaded discussions, integrated groupware, and shared whiteboards.

As mentioned in the previous section, email and mailing list server discussions are organized chronologically. This type of organization is good for many short discussions or written materials, but most discussions are not linear and well organized. One comment can generate ideas on many different tangents. In those cases, users may want to organize the discussion by topic. However, that does not always work well. What happens if one message in a discussion has ideas that relate to several different parts of the discussion? Topic-oriented and threaded discussion systems attempt to respond to this problem by keeping an archive and allowing different ways of

organizing the discussion. Due to the creative, inventive, and nonlinear nature of human conversation, it is difficult to develop an ideal method of organizing records of conversations. Many attempts have been made to address this problem, but each proposed solution has its advantages and disadvantages.

A topic-oriented discussion is one in which a single topic and its responses are grouped in a single long message, with the same title or subject description. Users can read the original item and all responses before adding a new response. Such systems rely on the users to respond appropriately or start new items in ways that make the conversation coherent. If they do not, the information may be disorganized. Many topic-oriented discussions also include a mailing list server capability, so when a new item is added to the discussion, an email message notifies all members of the group of the addition.

The information in a threaded discussion system is organized and displayed hierarchically, so users can see how the messages are related. Each posting or "article" in a threaded discussion has a topic or subject. Users can comment on the topic, see what others have to say about it, and reply to questions or other people's comments. All of the comments, replies, and discussions on a single topic are collectively called a "thread." The difference between topic oriented and threaded discussions is a matter of format and organization. Usually messages in topic-oriented discussions are listed chronologically on a single topic page while messages in threaded discussions are organized in an outline format with replies indented and listed directly under the message to which there is a reply. This is an ideal method for developing an on-topic dialogue, particularly when there are numerous sub-conversations occurring simultaneously. Web pages with information and resources can be linked to the discussion system. One drawback of this approach is that if participants respond in the wrong place in the hierarchy, the thread can become garbled. In addition, users who do not log on regularly may miss important announcements and lose the chance to contribute in a timely manner.

c. Data and Document Management Technologies

Data and document management activities, which include the collection, organization and search of documents, use databases and search engines to organize and retrieve data. Users contribute data individually to a shared database and retrieve data from it as needed. Data can be in the form of references, such as pointers to related work and Web sites, information, such as weather conditions, curriculum projects, research papers, and contact information for colleagues.

Some groupware packages, such as Lotus Notes or Lotus Domino, have built-in database capabilities while others provide gateways or connections to a specific database. Web search engines such as Google use the entire Web as an information database. Some sites have specific search engines that allow users to search for specific information within a site and many provide options to search the entire Internet as well.

For example, Lotus Notes is a document database that can store and manage collections of data of many types, such as spreadsheets, formatted text, Web pages, graphics, linked or embedded objects, and multimedia objects such as scanned images and faxes, voice/sound, and video. It incorporates a full text search engine to allow users to index and search documents based on user queries. It is a hypertext-based system, so that one document can contain a "link" to another document in the database or to documents stored on the World Wide Web. Individual users can also create links from one page to another.

d. Data and Document Sharing

Another way to collaborate electronically uses the network to display documents around which collaboration is to take place. These documents might be a plan, a research paper, a presentation, or results from an exercise. The purpose of sharing a document online might be to edit and develop it or simply use it as the basis of discussion. If collaborators are all contributing to the development of a document, comments or sections can be sent via email, or the document can be posted on a server, from which participants can directly download the document to their desktop computers, edit it, then email it or upload it. Downloading a document to edit requires that all participants have a compatible version of the software used to create the document. This

method of sharing documents also requires strict version control, which is a way of protecting the document so that earlier versions are not destroyed.

Several technologies support this type of collaboration, including group editing tools and Web page creation tools. Shared whiteboards can be used for synchronous discussion of shared documents, which is described in later section. Documents can be easily shared online by displaying them on a Web site. There are many tools for converting text to HTML. There are also programs designed to support group co-editing of documents. Annotation systems provide a means for commenting on shared documents.

Group-editing tools allow multiple users to access and update the same document, while keeping a record of all changes made to the original. When more than one person is working on a document, it is important that everyone have access to the current version, including the most recent notes and edits. It is also necessary to have a way of protecting the document so that earlier versions are not destroyed, and to deal with the possible conflicts that can arise when two or more people edit a document at the same time. This feature is called version control. Many group-editing tools have access control also. Some members have the authority to make changes, while others are only permitted to write notes with suggestions to the primary writers. Others have even more limited authority and may only read the document. Another useful feature of group editing tools is merging, which allows several versions or files to be merged into one.

2. Synchronous Collaboration

Synchronous collaboration manages or synchronizes the sending and receiving of dynamic text, audio, and video, such that only a single user can dominate a discussion at a time. However, a group of users can work together to share ideas in real-time. This mode of collaboration is also referred to as “real time collaboration”. It supports collaboration at the highest level and includes text-based chat sessions, electronic whiteboards, awareness knowledge, and live audio/video conferencing. Synchronous activities are also a good way to involve experts who are available for "one-time" presentations or discussions. Synchronous capabilities include:

- Audio/Video conferencing: audio/video session where users are able to see and hear each other electronically on a desktop computer
- Audio: real time aural information from a microphone to a speaker
- Video: real-time visual information from a camera
- Awareness: mechanisms that allow users to know who is on-line.
- Chat: real-time sharing of text data (i.e. real-time email: “instant” messages)
- Shared applications: ability to view and control an application on another’s desktop
- Shared desktop: ability to control the desktop of another computer remotely
- Virtual Teams: individuals forming and acting as a team by means of electronic collaboration tools or information services to accomplish a mutual goal, regardless of location
- Whiteboard: shared drawing board analogues to a “chalk board” that may be blank or display an image that a group of users can individually mark up and review in real-time

Point-to-point and multi-point communication are two modes of communication provided for synchronous collaboration. Collaboration tools that feature point-to-point communications require each computer system to handle all of its communication with other computer systems involved in a synchronous collaboration session. Point-to-point tools are effective only for a small group of users because communication bandwidth can rapidly become saturated as more users join a session. Collaboration tools that feature multi-point communication are applicable for small and large groups of users, since they provide server capabilities that manage bandwidth and facilitate communications between user platforms.

A main advantage of synchronous collaboration is that once a collaborator is in touch with the right person, answers are immediate. Material can be shared if both parties are in the same place. Synchronous collaboration also allows interactive sharing of ideas with several people.

Disadvantages of synchronous collaboration include the possibility that the other collaborator might not be the right person, difficulty in scheduling or getting

synchronized, and the fact that users can share only material that they remember to bring or have on hand.

Four technologies that support such interactions are online chat rooms, videoconferencing, shared whiteboards, and shared applications and desktop.

a. Chat

Online chat rooms are hugely popular as a social medium. Millions of people engage in chat via forums such as America Online. In online chat meetings, people come together, in real time over long distances, by typing into a computer. All comments are recorded on the screen, so participants can scroll back at any time to see what was said earlier. At the end of the conversation, ready-made minutes of the meeting are available. Some chat environments also include functioning Web pages and graphic "slides" that are displayed above the chat window. These types of multimedia features allow participants to:

- Exchange pictures during introductions
- View photos or slides illustrating a topic or point
- Show research graphs and charts

To participate in most "public" chat rooms on the World Wide Web, a Web browser is all that is needed, and in most cases, the appropriate plug-ins. The problem with these types of chat groups is that they may not focus on the topic of interest, and anyone can participate. An alternative to such public chat rooms is to find a service that supports the user's ability to create private chat rooms on the fly or to sponsor a "private" chat session. To do so requires that the event's sponsor purchase and install chat server software on a server. People participating in such a private chat need to install the corresponding client software on their computers. Most of this software is available for free downloading from the Web. Most chat clients have at least three windows, the chat area where the chat discussions appear, a text box where a user can enter his own messages, and an area containing a list of people who are in the same chat room. Online services that provide chat rooms, such as America Online, use their own proprietary software.

b. Videoconferencing

With a camera attached to their computers, participants view one another as the discussion occurs. Videoconferencing varies greatly in setup and quality depending on the manner of reception. Quality varies depending upon size and type of the network connection, which shortens or lengthens the lag between audio and accompanying video. Some forms of videoconferencing are designed for computer desktop use, while others are for use in a central studio or with special dedicated phone connections. They range from costly proprietary systems to inexpensive shareware and freeware. Desktop videoconferencing frequently provides a text window, or some other form of shared workspace in addition to voice and picture.

While videoconferences can be more immediate and exciting for participants than chat meetings they also present more technical challenges. For videoconferencing, systems vary from the highly sophisticated with document sharing capabilities to inexpensive desktop systems. The video, in the lower-end systems, rather than flowing continuously, appears in successive screen shots that change several times a second. In order to work properly, each participant's computer requires a digital camera. The quality of videoconferencing is also dependent on the speed of a participant's network/Internet connection. Slower speeds can significantly degrade performance.

c. Shared Whiteboards

Like having a whiteboard at a face-to-face meeting, shared whiteboards allow a document or image to be viewed simultaneously by two or more people in different locations. All participants can annotate the document using the drawing or text capabilities of the whiteboard software. Most shared whiteboard programs use different colors to distinguish annotations.

d. Shared Applications and Desktop

When users share applications one of the participants can take control of the application of the other participant allowing him to make corrections, changes and what ever he requires during the collaboration effort. The control has to be granted by the

owner and can be negated easily and without notice. It is a very useful tool in real time design or editing. Compared with shared whiteboards, users cannot make annotations. Similarly, desktop sharing is a technology that allows a user to share his own desktop, so the other participant not only has access and control to a specific application, but also the control of the collaborator's machine. Shared applications and desktop are used in cases of online help, or problem solving. It is important to note that this remote type of collaborative application needs to be wisely managed.

D. COLLABORATION ARCHITECTURES

1. Client/Server

A client/server architecture exists whenever a client makes requests of a server system. The system can be a module, a process, a program, or any other entity that can, in case of clients, make requests, or, in the case of servers, respond to requests. A client/server model is often mapped onto hardware platforms where the servers are specialized network nodes that provide service, and the clients are workstations that provide the user with graphical user interfaces to access the services of the server nodes.

A client/server architecture allows groupware applications to optimize the utilization of hardware and software resources at both the front end or the client computer application, and the back end database server, which provides a centralized “repository” of shared database information. Other advantages include the parallelism that can be achieved through delegating server tasks and thereby freeing up the client nodes to concentrate on optimizing the user interface or interaction. Client/Server architectures improve the performance of shared office data access in a LAN environment, and allow more users to access the same data often using their existing PC software.

Since servers and clients are connected through networks, networking is a requirement for client/server architectures. End-users need to be on the network in order to concurrently share or route information. Network architecture should support the necessary communication bandwidth for services offered by internetworked workstations to be usable and effective. There are several alternatives for networking architectures and they directly affect the network efficiency and performance, and therefore, the

performance of the collaboration applications that use the network as a communication medium. Identifying the right requirements and bottlenecks is vital since bandwidth is crucial for some of them, for example, videoconferencing.

Typical client/server architectures include file servers and database servers, which are very important services for collaborative computing. File servers, which can be dedicated or non dedicated, are designed to provide file services to multiple users. Through these servers, users can concurrently share resources, the most prominent of which is data. On the other side, database servers maintain the information base for the network, provide concurrent access to the information base, and maintain the consistency and validity of the data.

However, there are some other server components that are used for collaboration, such as video servers, fax servers, document changes management (editing and versioning), checking out and checking in of objects, and messaging servers for email transport. With the advances in the computing power of PC workstations, storage technologies and compression technologies, it is now possible to use video as a digital data type. It is thus necessary to have a server that can handle this type of data. Some technical problems limit the use of standard networks and file servers when dealing with video data types. A standard network can be rapidly saturated by video streams and thus higher throughputs are required. Storage is also a problem since video requires a large amount of disk space. Finally, there is a need for performance in the form of a predictable response time. The server must be able to deliver more information to the client before the client empties the client buffer and the delivery rate must be maintained at a constant rate. All these elements favor the need for video servers.

In most organizations, changes done in documents are important and they must be stored and tracked. In client/server architectures, users are making changes (modifying) to concurrently shared objects and those modifications need to be managed. The previous versions of the document as well as the newly updated versions must be stored. Normally, users want the latest version of a document, and the system should be able to provide it.

An alternative to the above approach is checking in/out the shared objects. These objects must first be checked out from a common area or library, worked, operated upon or modified and then checked in again. With this method, different users cannot concurrently modify a single document. In order to find and identify the different objects or documents, a unique identifier can be used or they can be found using a selection criteria.

Fax servers are becoming increasingly popular because of the wide spread of this type of communication. Fax servers are natural extensions of fax machines and instead of having a fax machine in the office or in a central place, users are able to send and/or receive faxes from their workstations. Users can even use their applications to send faxes by using the printing paradigm whereby any document is sent to others by “printing” it to the fax.

2. Peer-to-Peer Architecture

Peer-to-peer computing is the sharing of computer resources and services by a direct exchange between systems. These resources and services include the exchange of information, processing cycles, cache storage, and disk storage for files. Peer-to-peer computing takes advantage of existing desktop computing power and networking connectivity and allows economical clients to leverage their collective power to benefit the entire organization.

In a peer-to-peer architecture, computers that have traditionally been used solely as clients communicate directly among themselves and can act as both clients and servers and assume whatever role is the most efficient for the network. This reduces the load on the servers and allows them to perform specialized services, such as mail-list generation or billing, more effectively. At the same time, peer-to-peer computing can reduce the need for IT organizations to increase part of its infrastructure in order to support certain services such as backup storage.

In industry, peer-to-peer architecture involves more than just the universal file-sharing model popularized by Napster. Business applications for peer-to-peer computing fall into a handful of scenarios, and one of them is collaboration.

- **Collaboration.** Peer-to-peer computing empowers individuals and teams to create and administer real-time and off-line collaboration areas in a variety of ways, whether administered, unadministered, across the Internet, or behind the firewall. Peer-to-peer collaboration tools also allow teams to have access to the most up to date data. Collaboration increases productivity by decreasing the time for multiple reviews by project participants and allows teams in different geographic areas to work together. As with file sharing, it can decrease network traffic by eliminating e-mail and decreases server storage needs by storing the project locally. Peer-to-peer computing enables applications that are collaborative and communication-focused. High availability comes through the existence of multiple peers in a group, making it likely that at any time there is a peer in the group able to satisfy a user request. This stands in stark contrast to traditional computing models, where high availability comes through complex load-balancing and application fail-over schemes. Peer-to-peer computing leverages available computing performance, storage, and bandwidth found on systems around the globe, and works because people realize that there is value in sharing their power with others in order to reap the benefits when they need it themselves
- **Edge Services.** Peer-to-peer computing can help businesses deliver services and capabilities more efficiently across diverse geographic boundaries. In essence, edge services move data closer to the point at which it is actually consumed and acts as a network caching mechanism. For example, a company with sites in multiple continents needs to provide the same standard training across multiple continents using the Web. Instead of streaming the database for the training session on one central server located at the main site, the company can store the video on local clients, which act essentially as local database servers. This speeds up the session because the streaming happens over the local LAN instead of the WAN. It also utilizes existing storage space, and thereby saves money by eliminating the need for local storage on servers.
- **Distributed Computing and Resources.** Peer-to-peer computing can help businesses with large-scale computer processing needs. Using a network of computers, peer-to-peer technology can use idle CPU MIPS and disk space, allowing businesses to distribute large computational jobs across multiple computers. In addition, results can be shared directly between participating peers. The combined power of previously untapped computational resources can easily surpass the normal available power of an enterprise system without distributed computing. The results are faster completion times and lower costs because the technology takes advantage of the power available on client systems.
- **Intelligent Agents.** Peer-to-peer computing also allows computing networks to dynamically work together using intelligent agents. Agents reside on peer computers and communicate various kinds of information back and forth. Agents may also initiate tasks on behalf of other peer

systems. For instance, intelligent agents can be used to prioritize tasks on a network, change traffic flow, search for files locally or determine anomalous behavior and stop it before it effects the network as in the case of a virus.

According to Groove Networks, one of the leaders in peer-to-peer communication and collaboration, “it is not that the Internet cannot adequately serve as a communications platform, but rather that peer computing simply may be more cost-effective, more personally efficient and more flexible and adaptable to person to person communication.” It is more cost-effective because there is a reduction in centralized resources, and storage resources, and there is an optimization of network and computing resources. It is also more efficient because of the “sense of personal empowerment it engenders”. There is no setup required, everything that is needed is in place and all a user needs is to establish a connection with someone else to begin a shared session. This sense of personal empowerment only grows as innovation continues to occur at the edge of the network. In a peer-computing environment, functionality can be added directly (and more quickly) at the edge of the network. It is up to the end user to add the function, with no need to convince a centralized development team to make changes at the server. This is valid for collaboration in terms that when a the collaborative application needs “active content” there arises potential danger to other shared information on the centralized server. The relation between customers and centralized administrators sometimes turns adversarial. Peer computing has the potential to diminish the natural tension between administrators and end users.

E. STANDARDS FOR COLLABORATION TECHNOLOGIES

The International Telecommunications Union (ITU) has defined several communications standards used by collaboration tools for both multi-point and point-to-point communications. These standards have been vital in the development of collaborative tools because they provide the required common framework to make collaboration easier. For example, H.323 defines audio and video conferencing protocol for networks based on the Internet Protocol (IP). T.120 provides standards for data

conferencing capabilities, including application sharing, electronic whiteboard, chat, and file transfer functions.

The T.120, H.320, H.323, and H.324 standards comprise the core technologies for multimedia teleconferencing. The T.120 standards address Real Time Data Conferencing (Audio graphics), the H.320 standards address ISDN Videoconferencing, the H.323 standard addresses Video (Audiovisual) communication on Local Area Networks, and the H.324 standard addresses video and audio communications over low bit rate connections such as POTS (Plain Old Telephone System) modem connections.

1. T.120

T.120 is a list of recommendations for providing the transmission of information in multi-point multimedia communications. It is composed of many protocols to ensure that file transfer, whiteboard usage, and application sharing, can be used when two or more terminals are communicating. It is important to note that T.120 is independent of H.320. Information passed using T.120 does not necessarily contain video. T.120 defines the transfer of information in a variety of multi-media applications (online, www.ktln.com):

- Data only
- Audio and data
- Audio and video
- Audio, video, and data

In addition, the T.120 collection of recommendations will operate over many different types of networks:

- PSTN - Public Switched Telephone Network
- ISDN - Integrated Services Digital Network
- PSDN - Packet Switched Data Network
- CSDN - Circuit Switched Digital Network
- LAN – Local Area Networks

Extensions to the T.120 family are currently underway that will address communicating via ATM (Asynchronous Transfer Mode) and the H.324 POTS videophone.

The T.120 standard contains a series of communication and application protocols and services that provide support for real-time, multi-point data communications. These multi-point facilities are important building blocks for a whole new range of collaborative applications including desktop data conferencing, multi-user applications, and multi-player gaming.

Broad in scope, T.120 is a comprehensive specification that solves several troublesome problems that have historically slowed market growth for applications of this nature. Perhaps most importantly, T.120 resolves complex technological issues in a manner that is acceptable to both the computing and telecommunications industries.

T.120 is an open standard defined by leading data communication practitioners in the industry. More than 50 key international vendors, including Apple, AT&T, British Telecom, Intel, MCI, Microsoft, and PictureTel have committed to implementing T.120-based products and services.

T.120 provides exceptional benefits to end users, vendors, and engineers tasked with implementing real-time applications. The following list is a high-level overview of the major benefits associated with the T.120 standard.

- Multi-point Data Delivery: T.120 provides an elegant abstraction for developers to create and manage a multi-point domain with great ease. From an application perspective, data is seamlessly delivered to multiple parties in "real-time".
- Interoperability: T.120 provides a means for endpoint applications from multiple vendors to interoperate. It also specifies how applications may interoperate with or through a variety of network bridging products and services that also support T.120.
- Reliable Data Delivery: Error-corrected data delivery ensures that all endpoints will receive each data transmission. An application can even specify that each endpoint must receive each data packet in the exact same order.
- Network Transparency: Applications are completely shielded from the underlying data transport mechanism being used. Whether the transport is a high-speed LAN or a simple dial-up modem, the application developer is only concerned with a single, consistent set of application services.
- Network Independence: The T.120 standard supports a broad range of transport options, including the Public Switched Telephone Network (PSTN or POTS), Integrated Switched Digital Networks (ISDN), Packet

Switched Digital Networks (PSDN), Circuit Switched Digital Networks (CSDN), and popular local area network protocols (TCP/IP and IPX). Furthermore, these vastly different network transports, operating at different speeds, can easily co-exist in the same multi-point conference.

- Platform Independence: Since the T.120 standard is completely free from any platform dependencies, it will readily take advantage of the inevitable advances in computing technology. In fact, companies have already ported the T.120 source code easily from Windows to a variety of environments including OS/2, several versions of UNIX, and other proprietary real-time operating systems.
- Support for Varied Topologies: Multi-point conferences can be set up with virtually no limitation on network topology. Star topologies with a single Multi-point Control Unit (MCU) are common. The standard also supports a wide variety of other topologies ranging from those with multiple, cascaded MCUs to topologies as simple as a daisy-chain. In complex multi-point conferences, topology may have a significant impact on efficiency and performance.
- Application Independence: Although the driving market force behind T.120 was teleconferencing, its designers purposely sought to satisfy a much broader range of application needs. Today, T.120 provides a generic, real-time communications facility that can be used by many different applications including interactive gaming, virtual reality and simulations, real-time subscription news feeds, and process control applications.
- Scalability: T.120 is defined to be easily scalable from simple PC-based architectures to complex multi-processor environments characterized by their high performance. Resources for T.120 applications are plentiful, with practical limits imposed only by the confines of the specific platform running the software.
- Co-existence with Other Standards: T.120 was designed to work alone or within the larger context of other ITU standards such as H.320. In several places, T.120 also supports and neatly cross-references other important ITU standards such as V series modems.

The T.120 standard can be freely extended to include a variety of new capabilities such as support for new transport stacks such as ATM or Frame Relay, improved security measures, and support for new application-level protocols.

2. H.320

The H.320-series governs the basic video-telephony concepts of audio, video and graphical communications by specifying requirements for processing audio and video

information, providing common formats for compatible audio/video inputs and outputs, and protocols that allow a multimedia terminal to utilize the communications links and synchronization of audio and video signals.

Like the other multimedia teleconferencing standards, H.320 applies to multipoint and point-to-point sessions. The H.320 suite addresses videoconferencing over circuit switched services such as ISDN or Switched-56. The components of the H.320 standard are summarized in the Table 2 (IMTC).

Recommendation	Description
H.320	Narrow-band visual telephone systems and terminal equipment
H.221	Frame structure for a 64 to 1920 kbits/s channel in audiovisual teleservices
H.261	Video codecs for audiovisual services at Px64 Kbps
H.263	Enhanced reference picture selection mode
H.230	Frame-synchronous control and indication signals for audiovisual systems
H.231	Multipoint control unit for audiovisual systems using digital channels up to 2 Mbits/s
H.243	System for establishing communication between three or more
G.711	Pulse Code Modulation (PCM) of voice frequencies
G.722	7 khz audio-cpding within 64 kbit/s
G.728	Coding of speech at 16 kbit/s using low-delay code excited linear

(Source: International Multimedia Telecommunications Consortium, Inc)

Table 2. Summary of the Components of the H.320 Standard.

3. H.323

The H.323 standard was originally developed as an adaptation of H.320, which addresses videoconferencing over ISDN and other circuit switched networks and services. Since H.320 was ratified in 1990, corporations have increasingly implemented Local Area Networks (LANs) and LAN gateways to the Wide Area Network (WAN). H.323 has evolved beyond a logical and necessary extension of the H.320 standard to include Corporate Intranets and packet-switched networks generally. H.323 utilizes the Real-Time Protocol (RTP/RTCP) from IETF, along with internationally standardized

codecs. With the ratification of version 2, H.323 is also being used for video and other communications over the Internet.

H.323, in common with the other ITU multimedia teleconferencing standards, applies to multipoint and point-to-point sessions.

The components of the standard are summarized in Table 3 (IMTC).

Recommendation	Description
H.323	Systems document, describes overall operation and procedures for H.323 systems.
H.225.0	Specifies messages for call control including signaling, registration and admissions, and packetization/ synchronization of media
H.245	Specifies messages for opening and closing channels for media streams, and other commands, requests and indications.
H.450.X	Series of Suplimentary service recommendations. Defines signalling and procedures used to provide these telephony-like services
H.235	Defines the security framework used to provide authentication, encryption and integrity to H.323 systems
H.332	Provides large scale, or loosely-coupled conferencing based upon H.323.
H.261	Video codec for audiovisual services at P x 64 Kbps.
H.263	Specifies a new video codec for video over POTS.
G.711	Audio codec, 3.1 KHz at 48, 56, and 64 Kbps (normal telephony).
G.722	Audio Codec, 7 KHz at 48, 56, and 64 Kbps.
G.723	Audio Codec, for 5.3 and 6.3 Kbps modes
G.728	Audio Codec, 3.1 KHz at 16 Kbps.
G.729	Audio Codec, 8 kbps audio codec.

(Source: International Multimedia Telecommunications Consortium, Inc)

Table 3. Summary of the Components of the H.323 Standard.

4. H.324

H.324 addresses and specifies a common method for sharing video, data, and voice simultaneously using V.34 modem connections over a single analog (POTS) telephone line. It also specifies interoperability under these conditions so that videophones, for example, based on H.324, are able to connect and conduct a multimedia session.

Of the three ITU standards that address videoconferencing, H.324, H.323 and H.320, H.324 has the broadest impact in the marketplace because H.324 incorporates the most pervasive communications facility or POTS installed today on a global basis. In comparison, H.320 specifies videoconferencing over circuit-switched media such as ISDN and Switched 56, while H.323 extends H.320 video to corporate intranets, LAN's and other packet-switched networks. As a result, H.324 based products are expected to be prominent in the mass market/retail segment where PC's equipped with this capability are already available.

The H.324 suite consists of five recommendations: H.324, H.223, H.245, H.263 and G.723.1 (formally G.723). H.261 Video Compression and T.120 Data is also specified. Table 4 (IMTC) summarizes and briefly describes these recommendations.

Recommendation	Description
H.324	Defines a multimedia communication terminal operating over the Switched Telephone Network. It includes H.261, T.120, and V.34.
H.263	Defines video coding for low bit rate communications (typically less than 64 Kbps).
H.223	Defines a multiplexing protocol for low bit rate multimedia
H.245	Defines control of communications between multimedia terminals.
G.723.1	Defines speech coding for multimedia telecommunications transmitting at 5.3/6.3 Kbps.

(Source: International Multimedia Telecommunications Consortium, Inc)

Table 4. Recommendations of the H.324 Suite.

F. CHALLENGES AND TRENDS OF COLLABORATIVE TECHNOLOGIES

1. Challenges

Most organizations encounter difficulty not with the technology but with the manner in which people in the organization use the technology. Thus, the use of collaborative technology poses not only a technical challenge to organizations but also a managerial, organizational and cultural one. These issues need to be addressed correctly so that a successful collaboration environment can be developed and maintained.

While collaborative technologies make it easier to bring people together, they can also make it easier for people to pull them apart. This situation occurs because computerized communication methods do not transmit most of our nonverbal cues, which are important in establishing the richer meaning of a message by adding context. A large percentage of our meaning is conveyed via nonverbal cues. Facial expressions, body language, voice tone, expression, inflection, touching and distance are but a few of these cues. Emoticons were the first attempt at including nonverbal cues in text-based email. Video technology can show facial expressions and some body language, but more work is needed in order to capture more of the imprecise nature of human communication to make the meaning of the message received more precise. The real challenge is making the virtual encounters and collaboration efforts as real as possible by capturing the non verbal cues of human communication. If this can be done, collaboration in the future will be much easier than it is today.

2. Trends

Today, nearly every organization uses some type of collaborative data application with email by far being the most common. Most medium and large organizations use comprehensive collaborative platforms, called integrated collaborative environments (ICE), to schedule meetings, manage emails and build custom applications. IBM/Lotus Notes and Microsoft Exchange are the most popular examples of ICE applications. Collaboration has been evolving and three periods were identified by IDC. These are the pre-Internet age, the ICE age, and the contextual collaboration age. In the pre-Internet age, separate email, fax and voice messaging systems, costly X.400 value area networks for external messaging, personal calendaring/scheduling, proprietary client and server software, and internal workgroup email existed. Then, collaboration evolved to the ICE age where free SMTP Internet email existed, Internet standards appeared, new services and applications were introduced such as team collaborative applications as well as real time conferencing, Internet and Web hosted application services. These are separate from other business applications. All these applications and services provided users with functionality, ease of use and user control, but organizations realized that they were relying at the same time on other types of software to serve their customers and manage

their finances and web sites. They had to abandon their primary applications if they wanted to collaborate, and in addition, they were faced with completely new interfaces and environments. In the new age or the contextual collaboration age, vendors connect traditional business applications with collaboration features, such as presence awareness, instant messaging, real time conferencing, file exchange and virtual workspaces. The result is an ad-hoc, user driven, seamless collaboration within the context of business processes, applications and web sites. The main benefits of this contextual collaboration are (Mahowald and Lewitt, 2001):

- **Ease of use:** the transition will be seamless to users. The new option, tab or icon located within a familiar interface is the only new thing to learn.
- **Focus:** users' primary business work and collaboration happen concurrently from the same interface and use the same business rules which encourages solving problems as they arise rather than waiting until the problem escalates
- **Mobile access:** "context" refers to more than just the situation such as using the appropriate form factor also. Mobile users do not have the time or the display devices to access applications and information the way they would when sitting at their regular desks, so providing the exact features and information according to the user's context is very important.

Another trend to consider is the prediction that people will work and collaborate, synchronously, asynchronously, and semi-synchronously, and that organizations will be asking for more capabilities and that they will collaborate in all possible forms in order to achieve their collaborative goals. This fact has caused companies to include not only one type of tools or tools for just one type of collaboration. Moreover, the trend is that applications will be provided as suites with many functions offered. Finally, and related to the aforementioned issues, the cost of ownership will be lower. The trend of today's applications is towards a browser-based client that will be easy to use with little or no training required. Large applications, with dedicated personnel, servers, and which are complex and difficult to master are slowly disappearing from the market.

In the following chapter an ideal collaborative environment will be presented and a methodology to design and implement it will be proposed.

IV. COLLABORATIVE SYSTEM DEVELOPMENT

This chapter discusses what an ideal collaborative environment should look like independent of specific technologies or products. It then overviews existing methodologies for developing information systems and proposes a methodology, based in the traditional System Development Life Cycle (SDLC), to develop a collaborative system.

A. THE IDEAL COLLABORATIVE ENVIRONMENT

It is hard to define an ideal collaborative environment, because it will depend on the organization, context, problem, participants and other factors. Many authors have tried to define it and there are some agreements on this issue. Dargan proposes seven capabilities that a collaborative environment should have (Dargan, 2001):

- Rapidly find the right people with the right expertise
- Quickly organize and conduct virtual teams and meetings
- Enable cross-organizational collaboration to support the business lifecycle
- Build, find, and exchange information across organizational boundaries
- Deliver the right information to the right people as soon as it is available
- Provide and maintain sufficient security
- Employ technology and community standards

This list can be complemented by other characteristics or capabilities, such as:

- Allow different types of collaboration
- Keep a record of all collaborations for further reference

The following is a discussion of the five more important requirements for an ideal collaborative environment:

First, it should be easy to quickly organize and form teams and conduct meetings, whether the collaboration will be asynchronous or synchronous, in the same or in a different place. Corporate culture, procedures, and other means should support the quick formation of teams, otherwise the opportunity to collaborate might expire, because of time restrictions, patience of the potential collaborators, etc. The ability to quickly

organize, form teams, and conduct meetings requires both technical and organizational aspects. On the technical aspect, communications have to be reliable, secure, with high quality of service and across the whole organization. On the organizational aspect, the organization has to be prepared to perform collaborative work.

Second, it should be easy to find the right person with the right expertise. Sometimes people need someone else to collaborate because they have expertise in certain topics. The ideal collaborative environment should allow people to find the person they need. Directories, people finders, address books, yellow pages and other means to find different experts in different fields, and ways to establish communication with them are essential. The ability to find experts has to be flexible and robust enough to allow finding the right people even if partial information is available (e.g. search only by topic, by last name, by department). Finding people is not hard, but finding people with expertise in a specific topic that works in a certain place and has specific experiences is more difficult, especially if they work in different parts of the organization. Collaboration between organizations might help on this area (e.g. sharing personnel and expertise information). Another challenge is that in order to share and get expert information from another organization, compatible communications means have to be available. Currently, two standards compete to support directory service protocols: Lightweight Directory Access Protocol (LDAP) and X.500. The protocol standards are not compatible, although custom interfaces can be developed to exchange packets between the various commercial products used by different organizations. Vendors have begun developing software to implement meta-directory mechanisms, generally using LDAP as the preferred standard (Dargan, 2001).

Third, the ideal collaborative environment should use rapid and intelligent search tools to find information by keywords within their required context, pruning the search space to provide a few relevant matches. The tools should allow users to define the context of a keyword or phrase. For example, a search for “Pentagon news” could apply specific search criteria such as public newscasts about the Secretary of Defense, Navy, Army, Air Force, and Marines. In this way, the search is more focused giving more relevant answers. Intelligent search and retrieval tools should help, by providing more information of the document / image so that the user can determine if that match is really

what he is looking for. This approach makes the search more efficient, and helps the user in determining which documents are the most appropriate. Immediate access to information that grows every day will be a challenge for the next years. Technologies such as network caching and storage area networks (SAN) are being used to speed up information access (Dargan, 2001).

Fourth, a collaborative environment should enable cross-organizational collaboration to support the business lifecycle by giving people in the organization ways to brainstorm, exchange and develop ideas together, even if they are far away. In this way they can electronically develop products or services together. The challenge is that current workflow tools do not capture current organizations business rules, so they have to be adapted to them. Managerial problems such as who becomes the product originator or who is responsible for updating and maintaining it also arise. These type of problems force the organizations to develop plans and rules to manage and handle all the information related with these joint products.

Once the information is available it should be disseminated to the users, even if they didn't specifically ask for it. The system should have their users profiled, so when information is obtained and is available, it should be sent throughout the collaborative environment to all relevant users that might be or are interested in, or are looking for that specific piece of information. It is very important that the information is sent in a format that the user can read, so the applications users have should be included in the profile. Knowing this allows the system to send the information in the right format for that user. To implement this capability the ability to search and retrieve information has to be powerful.

A key issue in collaborative applications is security. Since there are many users, usually located in different locations, communications is accomplished through networks, Intranets and the Internet. There is a real danger that information might be modified, copied or denied by others, affecting its integrity, confidentiality and secrecy. The security systems need to be proactive, denying unauthorized access, detecting and disabling intrusions before damage or compromise occurs, and protecting systems from malicious code and viruses. Collaboration tools have to include current security services

such as virus checkers, firewalls and intrusion detection systems, and new developments such as Public Key Infrastructure (PKI) for private and public certificates. In general, every advance in the security field should be applied to this environment.

In order to have interoperability in this environment, all the applications have to talk in the “same language”. It is therefore essential that collaboration tools follow industry standards, for their underlying technologies in order to facilitate interoperability. This is an area where the industry is still evolving, but there is a big effort for defining and establishing standards, as it was discussed in chapter III.

Fifth, the system should allow different types of collaborations. A collaborative system and environment should have the tools and technologies to allow the organization to perform all the collaborative efforts they need and require.

Much of the collaboration done in organizations takes time and lasts long periods. During that period, lots of information and knowledge is created, shared and disseminated. An important issue is capturing and storing this information. Usually it will be necessary to go back and see what was said, what was done, etc, and if these tools do not capture, store, and archive this information, it will be impossible to learn from previous experiences.

B. INFORMATION SYSTEMS DEVELOPMENT

As in any information system, developing a collaborative system requires a formal methodology. This section reviews the classical development methodologies used in information systems. In the following section we adapt existing methodologies to collaborative system development.

A system life cycle divides the life of an information system in two stages, systems development and system operation and support. The system is first designed and built and then used, maintained and supported.

A methodology is needed to provide structure to system development. Methodologies ensure that a consistent, reproducible approach is applied to all projects. Methodologies reduce the risk associated with shortcuts and mistakes. They also provide complete and consistent documentation from one project to the next. This allows reusing

the work from one project to another, and people can understand better what was done before.

Whitten (2001) indicates that there are some principles that should underlie all systems development methodologies, and they are:

- Get the owners and users involved
- Use a problem-solving approach
- Establish phases and activities
- Establish standards
- Justify systems as capital investments
- Don't be afraid to cancel or revise scope
- Divide and conquer.
- Design systems for growth and change

Although these principles are general and intuitive, they are helpful for people that are in charge of developing an information system, and can also be applied in the development of collaborative systems.

1. The Traditional System Development Life Cycle

A traditional System Development Life Cycle (SDLC) consists of four fundamental phases – planning, analysis, design, and implementation – which lead to a deployed system. It is called a system development cycle, because it is highly iterative though a normal progression is to follow each phase in a linear order. Each phase consists of a series of steps, which rely on techniques that produce deliverables. These phases are shown in Figure 8.

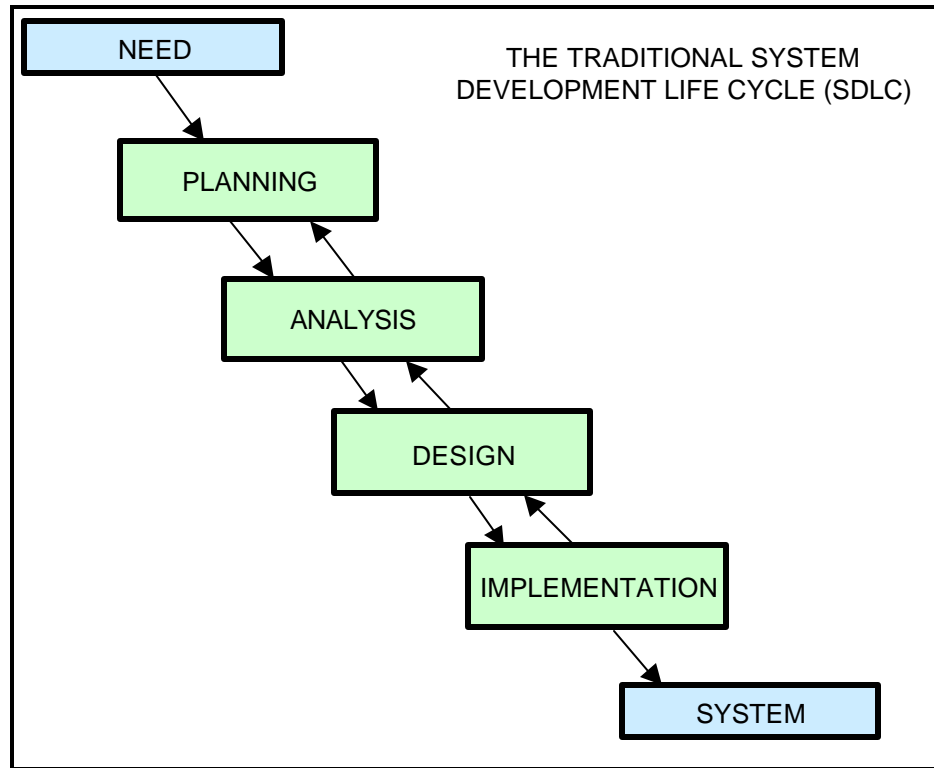


Figure 8. The Traditional System Development Life Cycle (SDLC) (From: Turban and Aronson, 2001).

The planning phase starts with a business need not being met. This includes possible opportunities, which are chances to improve the organization specific problems, that is preventing it from achieving its purpose, goals and/or objectives. If it appears worthwhile, a detailed feasibility analysis is conducted which further considers the viability of the project. The feasibility study addresses questions concerning the technical, cost and organizational feasibility. After it is completed and approved, a project manager is assigned and he or she creates a work plan, staff the project and adopts a methodology for managing it.

The analysis phase determines *what* the system is supposed to do. Questions like who are the stakeholders, what will the system accomplish, and where and when it will run are answered in this phase. Here the problem is analyzed, information is gathered, and processes and data are modeled. This phase primarily focus on the problem, independent of any technology that can or will be used to implement a solution to that problem.

The design phase indicates *how* the system will work, considering all the details of hardware, software, network infrastructure, user interface, and other technical details.

The implementation phase develops the system based on the specification developed during design phase. It includes not only the development of the system, but also testing and verification.

This methodology is also known as the Waterfall Model, because its phases follow each other in sequence, like a waterfall. This methodology states that the developer has to think about what is being built, then establish the plan for how it should be built, and then build it. The waterfall methodology forces analysis and planning before building the system. The process forces the analysis team to precisely define their requirements which may not be fully known. It requires the analysis team to define all the details up front. There is no room for mistakes and no process for error correction after the final requirements are released. There is no feedback about the complexity of delivering each one of the requirements. An easily stated requirement may significantly increase the complexity of the implementation, and may not even be possible with today's technology. Had the requirement team known this fact, they could have substituted a slightly different requirement that met most of their needs and could have been easier to achieve. In a fast moving technology, the waterfall methodology builds products that, by the time they are delivered, are obsolete. There is no early feedback from the customer. Because users usually have problems articulating their requirements, once they see what they could get, users will want something entirely different from what they initially specified. The waterfall methodology puts so much emphasis on planning that in a fast moving target arena it cannot respond fast enough to change

2. The Spiral Methodology

The spiral methodology addresses some of the problems introduced by the waterfall methodology. The spiral methodology also has four phases. A little time is initially spent in each phase followed by several iterations over all four phases. Simply, the methodology iterates over the processes of think a little, plan a little, implement a little, and then test a little. The document structure or deliverable types from each phase do not change in structure, but the content is very dynamic. As the methodology

progresses more detail is generated. Finally, after several iterations, the product is complete and ready.

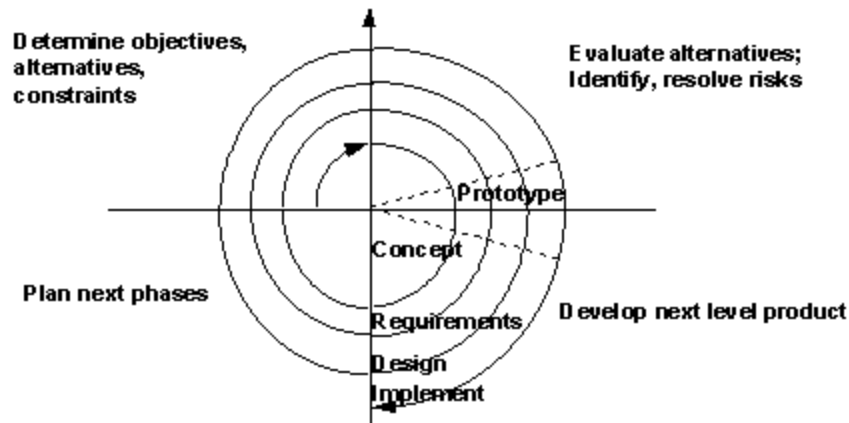


Figure 9. Spiral Methodology (From: www.controlchaos.com).

The spiral methodology is an incremental improvement on the waterfall methodology. It allows for feedback on the complexity of each requirement. There are opportunities where mistakes in the requirements can be corrected. The end user gets a peek at the results and can provide useful feedback information. The implementation team can provide feedback performance and viability information back to the requirement and the design teams. The product can better make use of technology. As new advances are made, the design team can incorporate them into the architecture.

The main problem with this methodology is that it has no effective controls of the oscillation of the spiral. More often than not, the length or number of cycles grow unbounded. There are no constraints on the requirement team to “get things right the first time”. This leads to the sloppy requirements from the requirement team that gets implemented by the implementation team to be eventually thrown out. The architecture team is never given a complete picture of the product and hence will not be able to complete an efficient global architecture. There are no firm deadlines. Cycles continue with no clear termination condition. The implementation team may be chasing a continuously changing architecture and dynamic product requirements.

3. Rapid Application Development (RAD) Methodologies

Rapid application methodologies adjust the SDLC so that parts of a system can be developed quickly and users can obtain some functionality as soon as possible. These include methods of phased development, prototyping, and throwaway prototyping.

The phased development methodology involves breaking a system up into a series of versions that are developed sequentially. Each version has more functionality than the previous one, as they evolve into a final system. The advantage of using this methodology is that users get functional versions quickly, but the disadvantage is that they don't get the final version until the end of the effort.

Prototyping involves performing the analysis, design, and implementation phases concurrently and repeatedly. System prototypes are quickly developed and presented to the users, who give feedback to developers on how they meet their requirements. The main advantage of this approach is that users can actually operate a version of the system, even if it is not fully completed. The feedback provided is then used to modify the prototype, and a new prototype can be developed (although further analysis might be needed to do this). The disadvantage of this approach is that changes are introduced quickly and there is no attempt to correct design decisions early on; instead they are repaired as the system evolves. On the other hand, if prototyping is done carefully with good design practices, it can be very effective. Figure 10 illustrates this process.

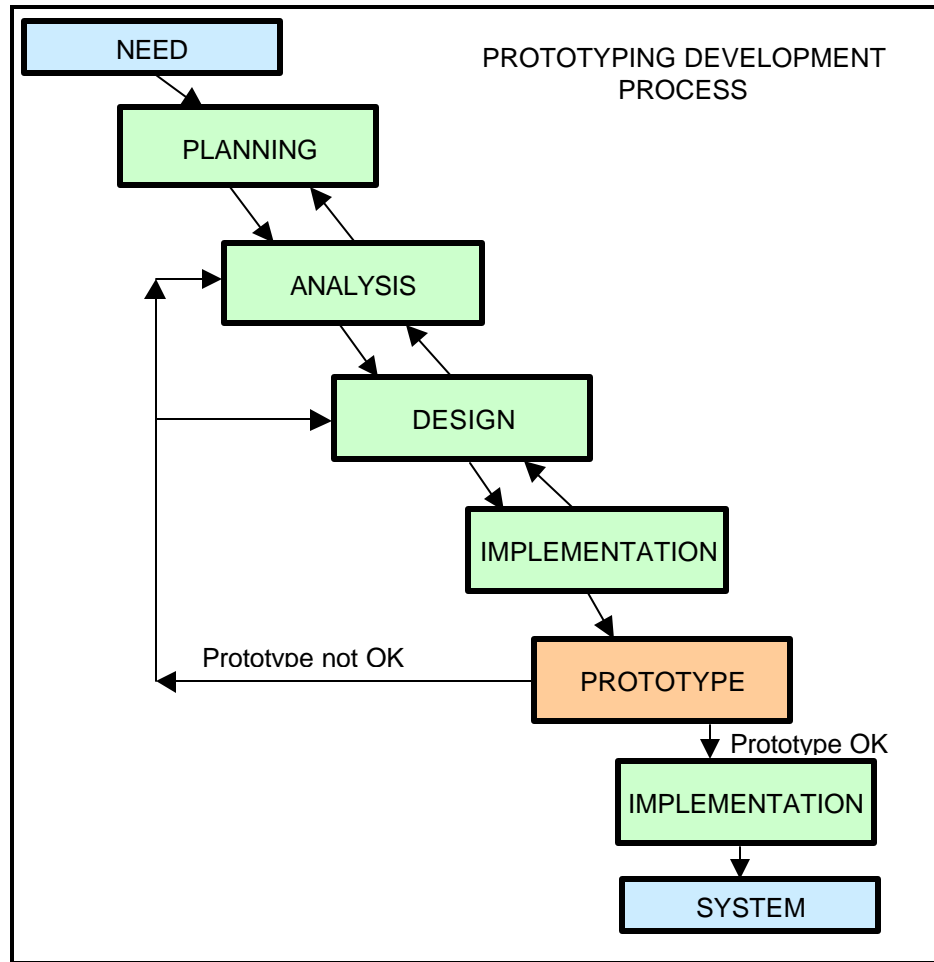


Figure 10. Prototyping Development Process (From: Turban and Aronson, 2001).

Throwaway prototyping is similar to both prototyping and the traditional SDLC. As in the SDLC, the analysis phase is thorough, but design prototypes are developed to assist in understanding more about the system being developed, especially when it is not clearly understood. Sometimes these prototypes are developed as pilot tests to learn about the user requirements and the final system to be deployed. This development process is shown in Figure 11.

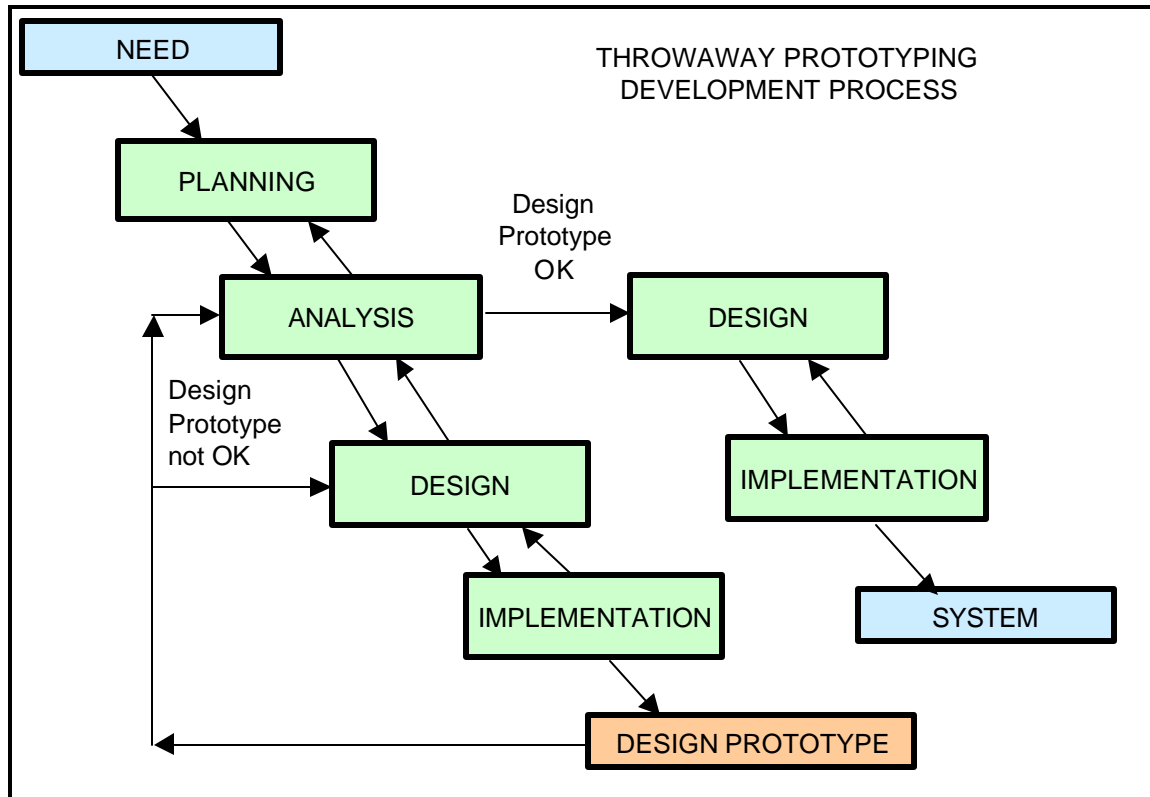


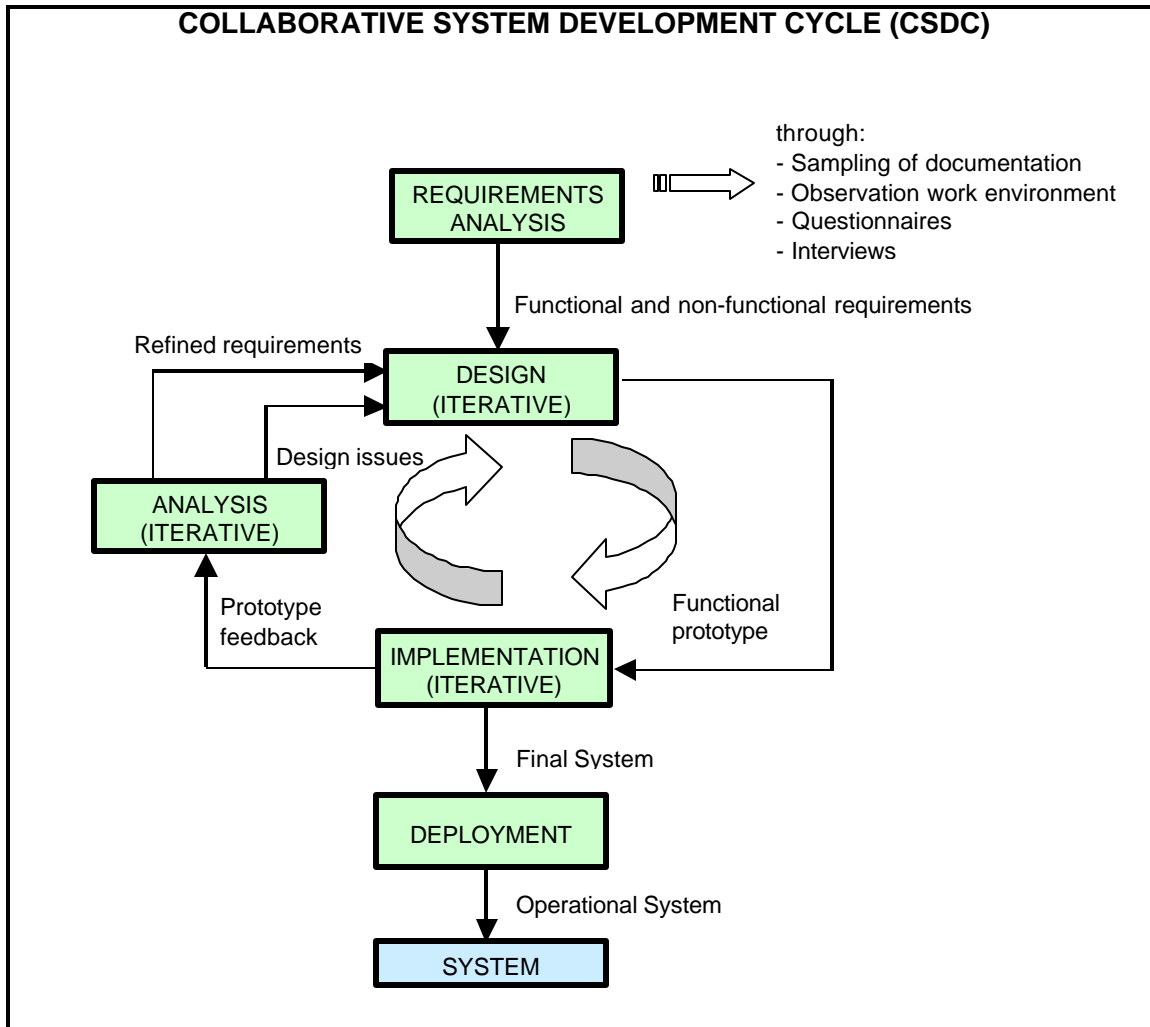
Figure 11. Throwaway Prototyping Development Process (From: Turban and Aronson, 2001)..

C. COLLABORATIVE SYSTEM DEVELOPMENT

In this section, a methodology is proposed to develop a collaborative environment. It is based on Rapid Application Development, but has been modified and adapted to meet the unique nature of collaborative environments.

For the purpose of this section, it is assumed that the organization has already determined that a need existed for collaboration for reasons such as the nature of the work and the need for different and distant units to coordinate tasks. The goal is to design and develop an environment that matches the organization's characteristics and needs.

The proposed methodology, called Collaborative Systems Development Cycle (CSDC), includes several phases, which are described and summarized in the following paragraphs, and shown in Figure 12.



Since collaboration affects the manner in which people relate at work, and as a result, procedures, corporate culture and other organizational factors can change, especially if collaboration is new to the organization. Therefore, the developing team must be multidisciplinary. It should, for example, include technical experts to analyze, define, and select the most appropriate collaboration tools for the organization's specific needs, as well as organizational and management experts to recommend the best measures to be taken to introduce this new environment to the organization. This section focuses on the technical aspects of selecting a collaborative environment and does not address any managerial, cultural or organizational aspects.

The proposed CSDC begins with a requirements analysis phase in which analysts capture the collaborative requirements of the organization. This is done through sampling of documentation, observing the working environment, using questionnaires, and conducting interviews. The output of this phase is a list of functional and non-functional collaborative requirements. An iterative process follows in which a prototype is designed, implemented and presented to the users for their input. Users provide feedback and the requirements are then refined, and new ones incorporated in the prototype. This iterative process is repeated until a final system is designed, implemented and approved by the users. The final phase is the deployment of the system. This phase includes the final installation of the system and the implementation of all managerial, cultural and organizational measures required for the deployment of a new collaborative system in the organization.

1. Requirements Analysis Phase

In this phase, the developer obtains the requirements of the system to be developed from the user. The developer then determines the scenario, type of data, intended audience, number of participants, and the processes or actions performed with this data and how collaboration inside the organization is affected. The output of this phase is a list of functional and non-functional collaborative requirements. For example, a functional requirement might be a requirement to share a document with five people simultaneously regardless location. An example of a non-functional requirement might be that the system must be very well documented for training purposes. It is important to emphasize that at this phase of the project, the developer is only determining what the customer wants and requires in order to solve any problems, but not, how to solve them.

Four methods are proposed to collect user's requirements:

- Sampling of existing documentation, forms and databases
- Observation of the work environment
- Questionnaires
- Interviews

These methods allow the developer to determine and model the collaborative environment requirements which will be used in the design phase to determine the most

appropriate technologies and tools for the organization. The idea is to determine the level of collaboration required given the characteristics of the desired collaborative environment. These fact finding methods also help the users to discover their requirements since sometimes they only have a vague idea of what they require.

The purpose of the sampling of the documentation is to understand how the organization is structured, who the main players are and their relationships with each other, what documentation already exists describing the problem or collaboration needed, and what type of data and information exists, and how often it is exchanged inside or outside the organization. The team assigned to this task needs to have some experience in collaboration approaches and technologies, since they need to identify documents relevant to collaboration.

By observing the work environment, analysts get a good feel for how the organization functions by noting what the people do, how they do it, how they relate to each other, how often they collaborate and the ways in which collaboration already exists in the organization. Experienced analysts are needed to perform this task so as to be able to detect problems and better understand the existing collaborative environment. If there is no existing collaboration, an experienced analyst might be able to detect areas where collaboration is required or validate what the users are requesting. The analyst must be careful not to disturb or interfere in normal activities since people's behavior might change, leading analysts to draw the wrong conclusions.

By using questionnaires, the analysts collect information and opinions from respondents. These questionnaires can be mass-produced, distributed to large groups of people, results can be collected and uniform responses maintained. The questionnaire should be distributed a cross-section of the organization in order to obtain a broad response. All answers should be gathered, analyzed, summarized to produce a list that represents the organization's requirements. It is important to determine the relative importance of these requirements since not all of them can always be satisfied. The manner in which to select which requirement to satisfy first is called relative ordering.

The results of the questionnaire should enable a developer to determine which technology, or which combination of technologies, are best for the specific case. A

questionnaire should be designed in such a way that it starts with general questions and ends with detailed questions. In this way, the developer can use the answers to match the requirements with existing technologies. At a later stage, these technologies are matched with existing commercial products. A proposed questionnaire is shown in Appendix A.

Finally, interviews are used to complement the other methods. They are used to discover new facts, clarify already known facts, verify facts, get the user involved, generate enthusiasm and solicit ideas and opinions. Usually interviews are conducted after the other methods are performed. Interviews provide a good opportunity to speak directly with the users, and if they are well structured and defined, can result in insightful and useful information. When conducting interviews, it is important to determine the key people to be interviewed since interviews are a selective activity when compared to the questionnaire, which is more general. Appendix B shows some guidelines for conducting interviews (Whitten, 2001).

2. Design Phase

The design phase starts after the requirements analysis phase is completed and the developer obtains a general understanding of how the organization works, the when, what, why, who and where of collaboration. In this phase, the requirements are matched with existing collaborative technologies. The developer analyzes the different ways to design a system in order to fulfill those requirements. This analysis not only includes technical aspects, but also the managerial, cultural and organizational aspects. After identifying candidate solutions, each one must be analyzed in terms of technical, operational, economical, risk and schedule feasibility, and one will be proposed which best satisfies the technical, operational, economic, risk and schedule feasibility. For example, a solution might be the best technically, but costs more than the allocated budget, or will take more time to implement than the time available to do so. The output of this phase, will be some managerial, cultural and organizational recommendations, and a technical solution. With the complete design, a set of specifications reflecting the business requirements is presented to the user for approval.

The results of the questionnaire are used to determine the appropriate collaboration technologies using a decision tree approach. Using a decision tree the

developer matches different requirements obtained during the requirements phase until a specific technology recommendation is obtained. The system starts with the time/place framework, followed by the action to be done, for example sharing and discussing, the data type to be used on that interaction such as text or video, and the intended audience. Up to 5 people can be considered a small audience, between 5 and 10 a medium audience, and more than 10 is considered a large audience. There is also some other information presented the purpose of which is to complement what was already explained. The capability to make annotations and/or changes, and the expected response time are used to help the developer determine the best technology to use. Even though the matching process is designed to start with the time/place framework information, a developer could start with the additional characteristics and eventually determine a technology, but in some cases, it could be too broad and does not help much. As mentioned previously, the main and recommended way to traverse the decision tree is to start with time, place, type of action and type of data (left to right).

The matching criteria focus first on where the collaboration will take place and if it will be synchronous or not. This is the usual and most popular way to classify the different collaborative technologies. Later, the questionnaire focuses on what type of activity will be done during the collaboration process. This question helps to narrow the search of the technology, and it is a differentiator between them. Activities such as sharing, discussing or displaying make the difference between different technologies. Once the type of interaction to be implemented is known, the type of data that will be used needs to be determined. This is important since when combined with the type of interaction and intended audience gives a very narrow search result, which in fact, is the required technology. All the different technologies have other characteristics, but in most cases, they are too broad and general in determining a specific technology. A user can start with them to determine a specific technology, but it will be very difficult to determine a technology without knowing more since it is shown as complementary to the previous process but when combined with the previous matching procedure can give a much better detailed idea of the technology.

In order to make it more presentable and readable, the decision tree was split into four parts with each one representing one of the quadrants of the time/place framework

matrix. In this way, users can traverse the tree easily and obtain the corresponding technology. These trees are included in Appendix C.

For this thesis, a simple prototype of an expert system was implemented using a trial version of the Exsys CORVID software. The main purpose of the prototype is to help a developer determine the best collaborative tools for a set of requirements that the user specifies to the system. It is based on the decision tree described earlier.

The user interface is simple and consists of short questions that the user has to answer by selecting from options that the program presents. Since more than one option can be selected, check boxes were used as the input option. The prototype includes four questions, and after processing, provides the results, which consists of one or more collaborative tools.

Figures 13 and 14 show some screen shots of this prototype. It can be seen that the user has to answer some questions and the system provides the best collaborative technology for the entered requirements.

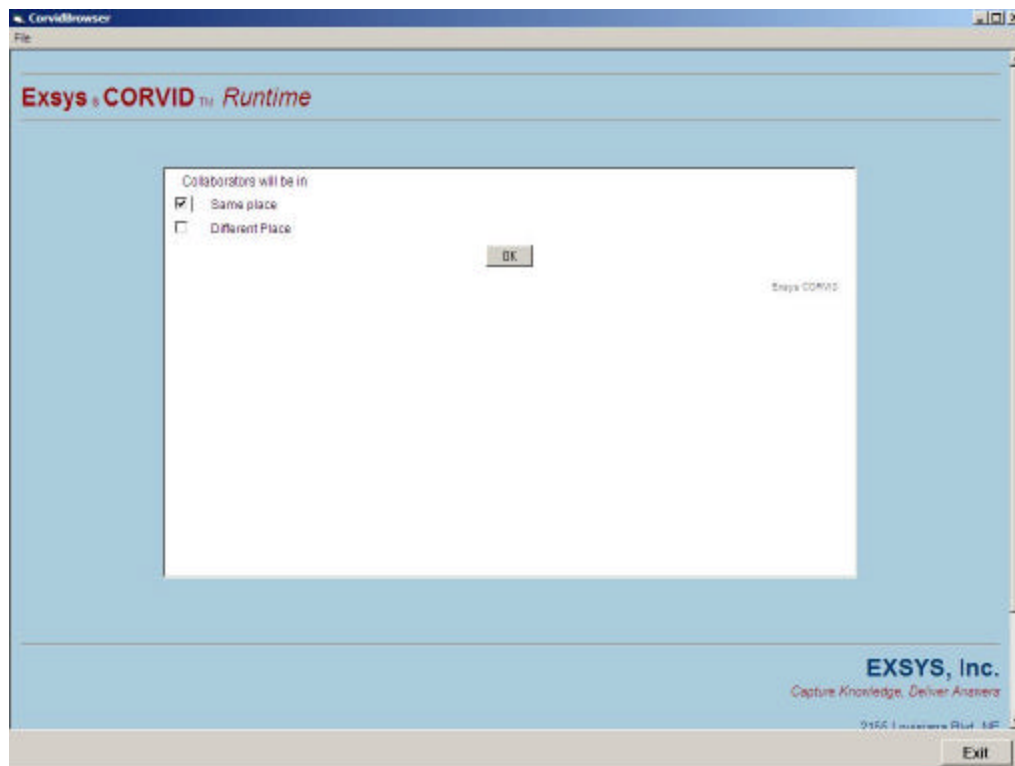


Figure 13. Expert System Requirements Input.

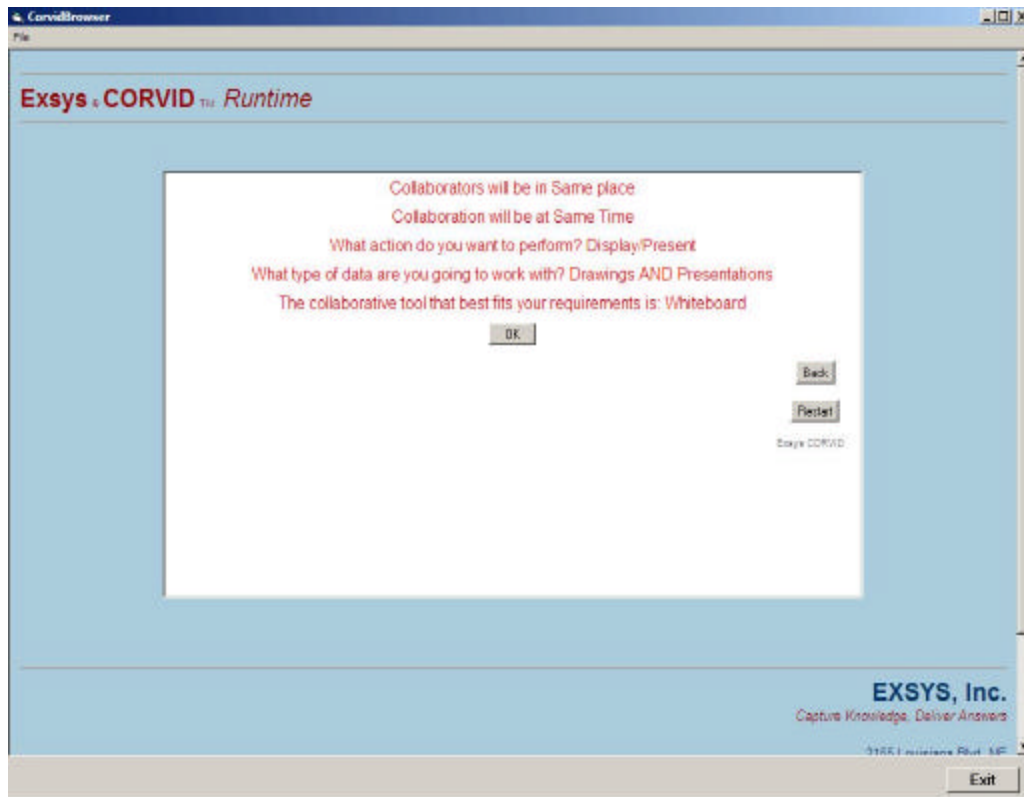


Figure 14. Expert System Recommendation.

The expected result is not only one technology since, usually in organizations, the collaboration needs are broad and affect various aspects.

An important decision addressed in this phase is whether to build the system in-house, or integrate existing commercial collaborative tools and products. Organizations are better off with the latter choice since such a large number of technologies, tools and products are on the market today and it is not cost/effective to start developing a new product. It is a long and costly activity. It is better to analyze the different alternatives in technologies and products and choose the one(s) that best fits the needs of the organization.

3. Implementation Phase

In this phase, the already designed system is built and the chosen technology and specific tool are matched. Activities include building networks, installing and testing new software, and writing and testing new software if necessary. This last activity might not

be necessary if commercial applications are procured. However, sometimes some code must be written to interface with existing systems.

A prototype is built and presented to the user for testing and exploration. This prototype will show the users what the final system will look like and whether it will improve communication and collaboration processes. It is during this testing phase that the user might find new requirements or refine the previous ones. Tests have to be conducted both on individual system components as well as the overall system.

4. Deployment Phase

The deployment phase is the last phase before the system becomes operational. This phase consists of deploying the system on a specific date, or in stages, at one or several locations of the organization following a deployment plan. This plan specifies when the new system will be operational, when and how all new procedures, rules or directions are to be in place. The plan also includes testing the system in the real environment as well as training the users in using, operating and maintaining the system. It is during this phase that most of the managerial and organizational aspects are put into practice, and where special attention must be paid to these issues.

In the following chapter, an analysis and comparison of some of the main collaborative tools existing in the today's market will be done. Special attention is paid to those tools mandated by the US Navy to be used in collaborative efforts.

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V. COLLABORATION TOOLS

This chapter presents an overview and comparative analysis of some commercial collaborative tools on the market today. Products from Microsoft, IBM/Lotus, Sun Microsystems, and Cybozu were chosen for the analysis based on their market share and relevance to DOD. The discussion in this chapter is based on the collaborative technologies classification presented in Chapter III. It is interesting to note that in an August 2001 message, DOD established the “use of NetMeeting and SunForum as the basic building blocks for DOD’s collaborative strategy”. The same directive authorized the use of any tool that is interoperable with, integrates or incorporates NetMeeting/SunForum.

A. CHARACTERISTICS OF A GOOD COLLABORATIVE TOOL

An ideal collaborative tool should have the following characteristics:

- **Simplicity:** The tool should require only a moderate level of expertise to implement it into the existing IT infrastructure and to integrate new applications. From the user’s point of view, it should have a friendly, intuitive and easy user interface, so that using the tool doesn’t distract the user from collaborating.
- **Standardization:** Tools should adhere to industry standards, as opposed to proprietary protocols. This is essential for cross organization collaboration.
- **Reliability:** Since these applications support vital processes within the organizations, they should be highly reliable.
- **Scalability:** They should easily scale upward and downward to meet changing organization needs.
- **Security:** Security is a key element in today’s business operations, especially in a DOD environment.
- **Interoperability:** The tools should be able to interoperate and exchange data with other systems.
- **Configurability:** The tools should provide a reasonable amount of configuration access points to allow administrators and users to tailor their environment for their particular needs and preferences.
- **Web-based:** In today’s networked world, collaboration tools need to be web-based, so organizations can leverage those connections.

B. PRODUCTS FROM MICROSOFT

1. MS SharePoint Team Services

SharePoint Team Services is a web-based tool designed to work with small to medium size teams inside an organization to help them to organize, share, distribute, and discuss data and information in a common place, in an asynchronous way. This allows workgroups (5 to 75 people) throughout the organization to coordinate their work through the organization's Intranet or the Internet using their browsers. Typical activities are sharing and managing different types of documents, post and read announcements, participate in threaded discussions, keep a list of contacts, perform and answer surveys, assign and control individual or group tasks, post and announce general events or regarding to the project, and maintain a list of useful links.

Lists are central to the operation of a SharePoint team web site. They are just database tables, but the power comes from the fact that users can create them, update them, display them, and if necessary delete them using standard web pages.

Figure 15 shows the main page of a SharePoint team Services web site created for this thesis.

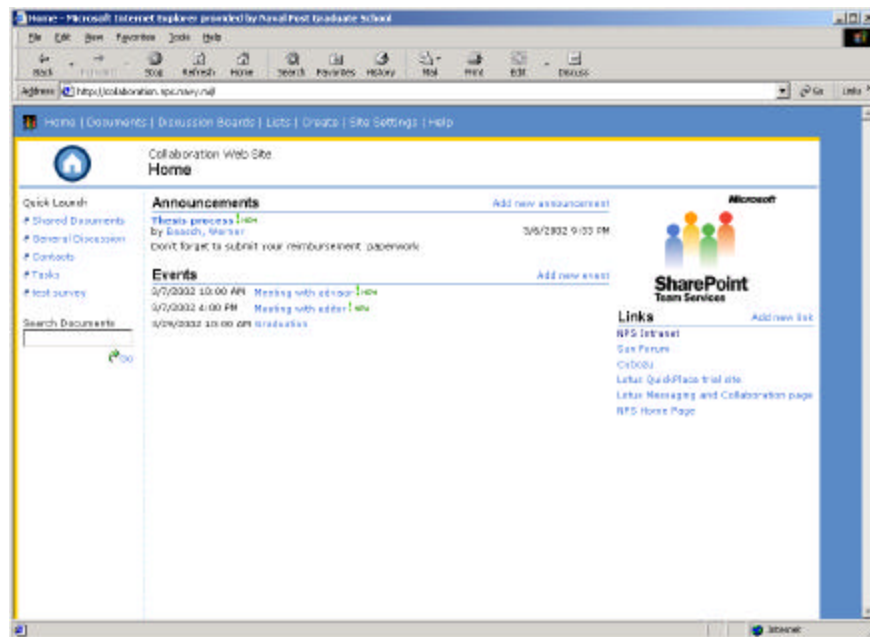


Figure 15. MS SharePoint Team Services Home Page.

SharePoint team web sites provide the following services to anyone with a web browser, connectivity to the server, and the necessary permissions:

a. Document Libraries

Document libraries are used to read or edit documents that are stored there. Information about the documents is presented, such as the name of the file, and the name and date of the person who last modified it. Different people can discuss documents, and their comments are added to the document to be viewed later (this is what in Office is called Web Discussions).

A SharePoint team web site document library has two components: a folder full of documents and a list that describes them.

(1) Web Discussions. After an Office 2000 or XP user saves a document to a web server as HTML, web visitors browsing that document can make comments using a discussion toolbar. The discussion feature allows to make annotations by adding “yellow sticky notes” to the document and to share those notes with other team members. These comments are stored separately from the document itself. Then, when the document creator opens the document all the comments appear seamlessly merged. Figure 16 shows this feature.

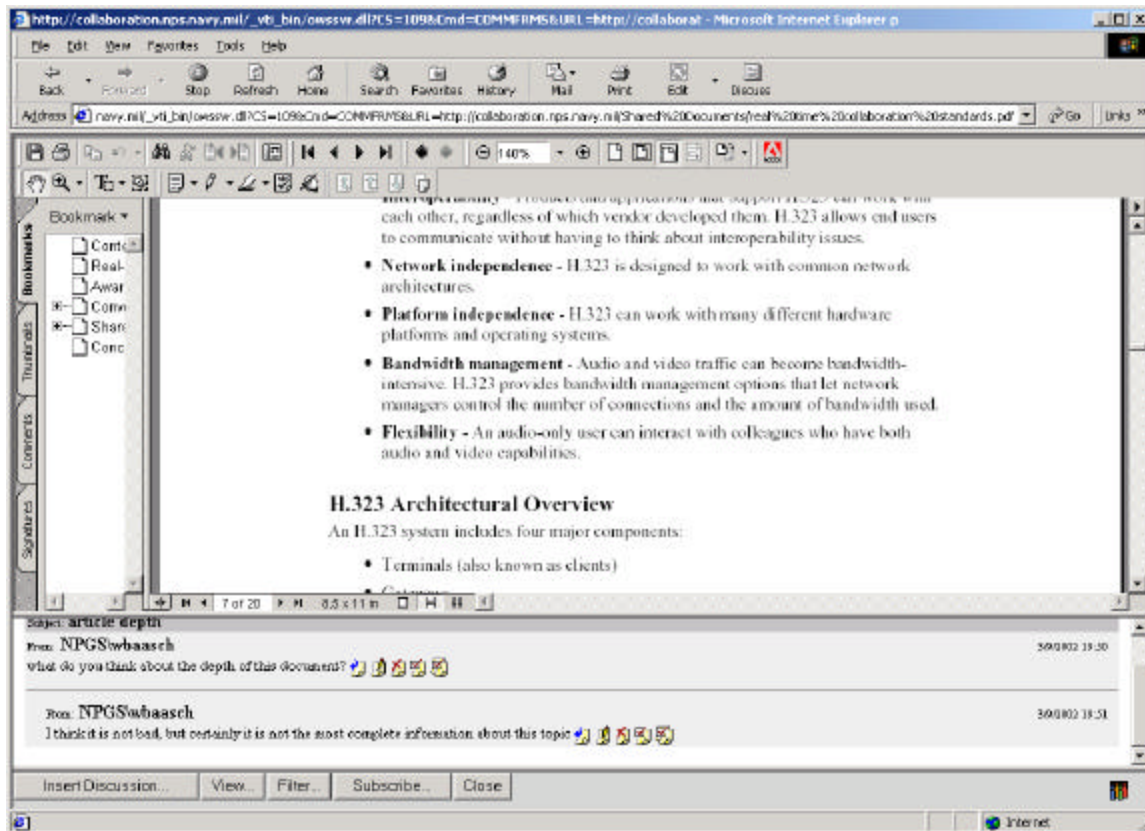


Figure 16. MS SharePoint Team Services Document Discussion Page.

(2) Search Page. This feature uses Microsoft Indexing Service to search for documents within the current SharePoint team web site.

The clients for these features are either a browser (for web based tasks) or standard Office applications (for document creation and retrieval).

Figure 17 shows the document library main page, which displays a list of all shared documents with the date of their last modification and the name of the person who modified them.

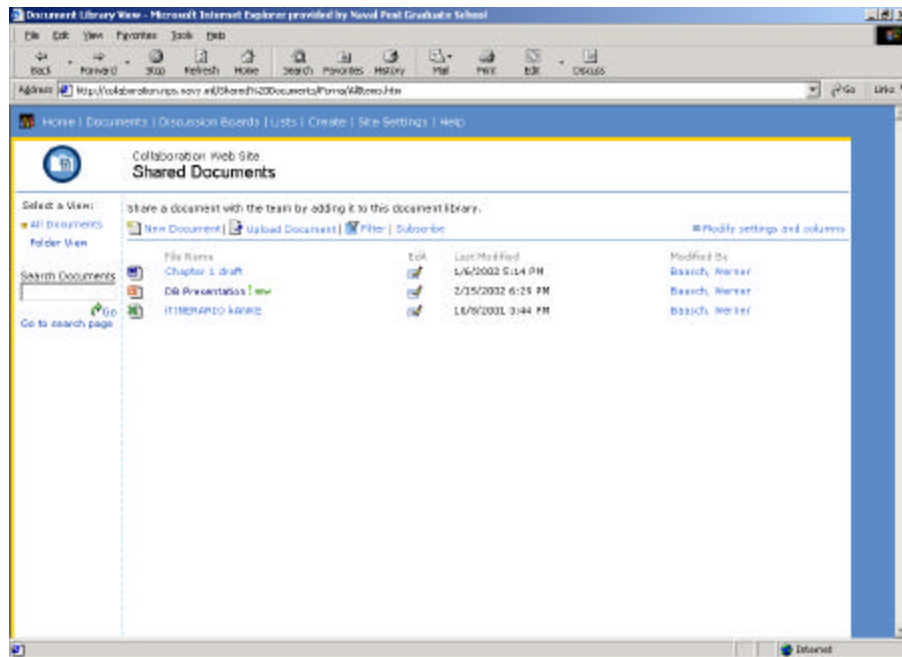


Figure 17. MS SharePoint Team Services Document Library.

b. Discussion Boards

Within a team web site users can create as many discussion boards they want, and each one of these can accommodate an almost unlimited number of threads and messages. Messages can be sorted and old ones can be purged automatically.

The discussion board works like an Internet newsgroup. Members can post new messages, respond to existing messages, and view messages in their entirety or in condensed lists. The team web site administrator can purge and correct messages, alter discussion board settings and defaults, and so forth. If security settings permit, team members can initiate and control their own discussion boards, and whoever posts a message can subsequently revise or delete it. Figure 18 shows a discussion board example.

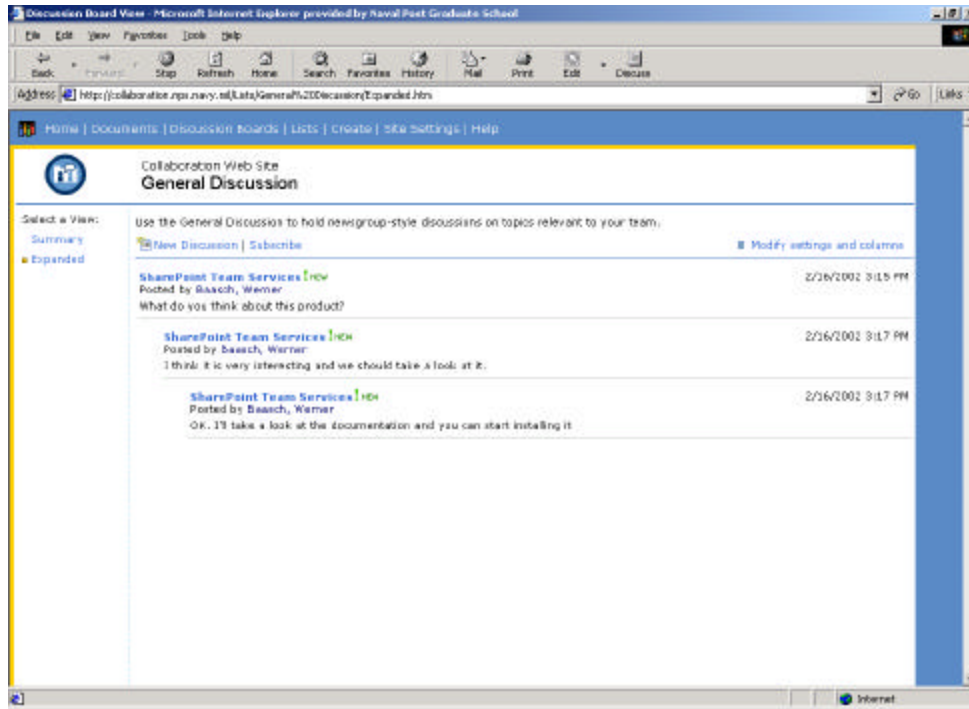


Figure 18. MS SharePoint Team Services Discussion Boards.

c. *Lists*

Lists are the basic unit of storage in a SharePoint team web site. They can contain a list of announcements, a list of upcoming events, a list of scheduled tasks, a list of team members or contacts, a list of excuses, or anything else that the user might like or need.

The complete set of lists that can be created includes a custom list, a document library, a survey, a discussion board, links, announcements, contacts, events, tasks and import spreadsheets.

From these lists, surveys are particularly interesting. They allow users to make surveys online by helping users to design a form people can use to record their views, let the survey population fill out the form and analyze the results, both graphically and in text mode. Figure 19 shows the menu for creating new lists.

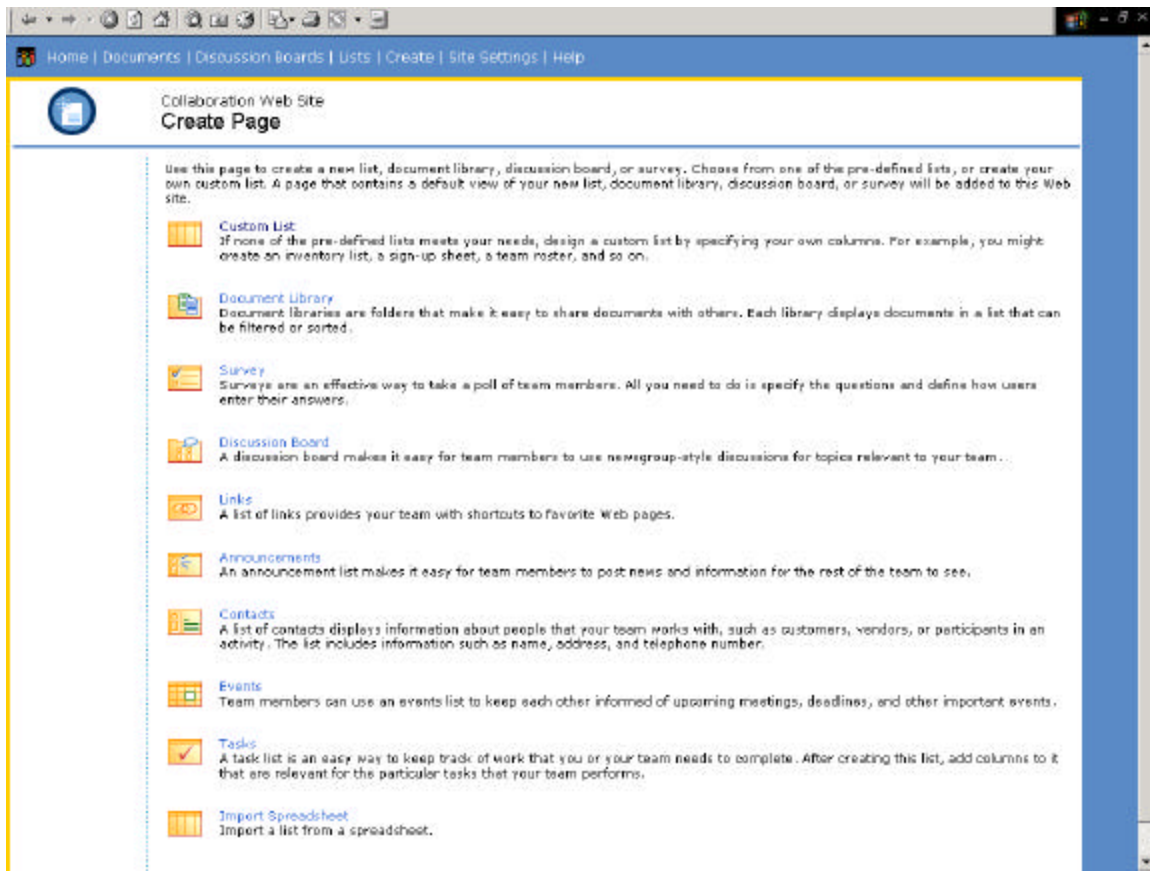


Figure 19. MS SharePoint Team Services List Creating Menu.

d. Subscriptions

With this feature, team members can ask to be notified whenever a specified document or folder changes (insertion or deletion of a document). SharePoint detects those changes and sends the notifications by email. Users can set the notification criteria, indicate email address where to send the notification, and indicate how long SharePoint Team Services should accumulate changes before sending them. Figure 20 shows the subscription page.

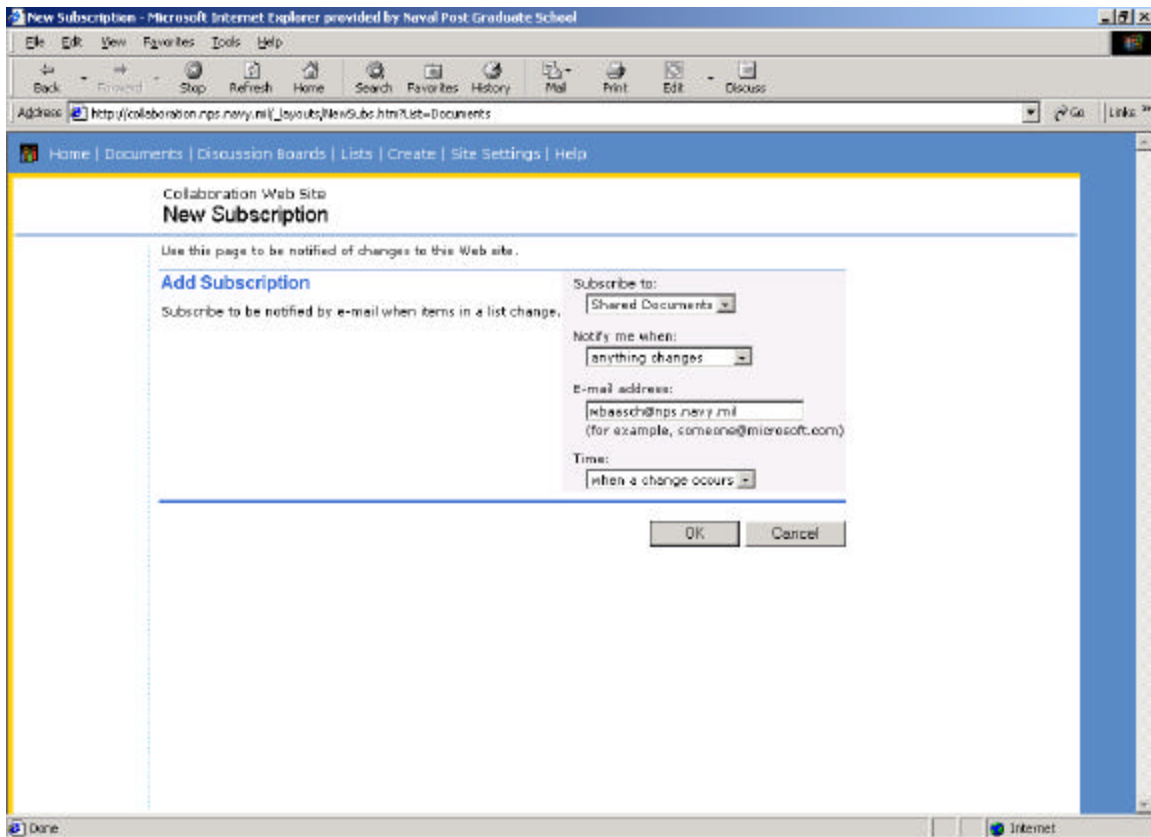


Figure 20. MS SharePoint Team Services Subscription Page.

e. *Administration*

SharePoint Team Services provides users different ways to display the data and information. Some settings are particular to a specific list, and others affect the entire web site. Administrators have several tools, which allow them to modify web site settings and administer the site, user information, and site content. New users can be added and invited to participate in the team site, and subwebs can be created.

Users can have different roles that can be assigned by an administrator:

- Administrator - View, add, and change all server content; manage server settings and accounts
- Advanced author - View, add, and change pages, documents, themes, and borders; recalculate hyperlinks
- Author - View, add, and change pages and documents
- Contributor - View pages and documents, view and contribute to discussions

- Browser - View pages and documents

This product was designed for use by as many as 500 to 600 people who work together as a group, but the optimal number is smaller. If there are several teams working in the organization, it is better to create a separate SharePoint team web site for each one.

SharePoint Team Services runs on Microsoft Windows 2000/XP computers with Internet Information Services (IIS) 5.0 installed. Since it is a server-based application, it requires administrator privileges to install it. Share Point team Services installs the following items:

- SharePoint team web site application components: these include web pages, ASP pages, ActiveX controls, and so forth
- Microsoft FrontPage Server Extensions 2002: if the web server already contains an earlier version of the extensions, installing this product will upgrade them
- Microsoft Data Engine (MSDE): this is essentially a version of Microsoft SQL Server, but it lacks the tools the user needs to design and manage their own databases. If there is already a copy of SQL Server running in the network, SharePoint Team Services can use that installation rather than MSDE.
- It also installs a team web site in the Web Server's root folder. If there was already a home page, the setup program prompts the user to either replace it or save it with a different name.
- If the computer has only one virtual web server, the installation adds the FrontPage server extensions and other features to that server automatically. Otherwise, the setup program will ask the user which servers to add the extensions too.

Scalability is achieved through the selection of the database engine that is used with SharePoint Team services to support web document discussions and document libraries. The version of MSDE that installs by default supports up to three virtual servers running on a Web server to support up to 50 users. For high traffic or shared environments, SQL 7.0 or later is needed. With SQL Server up to 1000 virtual servers per Web server for SharePoint Team Services can be hosted.

The system requirements are:

- Memory: 128MB

- Hard Disk: 70MB of available hard disk available; 5 MB of available hard disk space for each provisioned web site
- OS: Windows 2000 Server, Windows 2000 Advanced Server or Windows 2000 Datacenter Server with Internet Information Services (IIS) 5.0 or later, including Internet service and Service pack 2 (SP2).
- Programs: Internet Explorer 4.01 or later, or Netscape Communicator 4.75 or later, running on the Windows operating system, IIS 5.0, Microsoft Data Engine (MSDE) or Microsoft SQL Server 7.0 or later

The advantages of this tool are its ease of use, strong administration controls and integration with FrontPage. Setting up a team web site is simple. For organizations that don't want to host their own servers, there are Web Service Providers than can host SharePoint Team Services web sites for them. The administration tools allow administrators to easily log on and modify contents and create subwebs, as users can modify their own accounts with their browsers. For organizations that want to have better-looking sites, it is fully integrated with FrontPage 2002, giving administrators the chance to apply themes or other web designs.

The main disadvantages of the tool are its limited amount of users and limited search capability.

2. MS SharePoint Server Portal

Microsoft SharePoint Team Services can be considered as a subset of Microsoft SharePoint Server Portal, or the latter as an extension of Microsoft SharePoint Team Services. Both have the common goal of addressing information sharing needs of an entire organization. Both products give users the ability to organize information, readily access that information, manage documents, and enable efficient collaboration in a browser and Microsoft Office environment. The main difference is in the scale. While Team Services is oriented to teams inside an organization, Portal Server is oriented to the entire enterprise.

SharePoint Portal Server 2001 creates a portal Web site that allows users to share documents and search for information across the organization and enterprise, including SharePoint Team Services-based Web sites within one extensible portal interface.

Additionally, SharePoint Portal Server includes robust document management features that allow organizations to incorporate business processes into their portal solution.

SharePoint Portal Server offers the following functionality:

- Publishing on a dashboard site
- Searching across multiple locations
- Document access based on user roles
- Version tracking of multiple documents
- Document routing for review and approval

Like Team Services SharePoint Portal Server uses roles to control access to content. Coordinator, author, and reader roles can be assigned to users based on the tasks they perform. Each role identifies a specific set of permissions: coordinators handle management tasks, authors add and update files, and readers have read-only access to published documents. SharePoint Portal Server also offers the option of denying a user access to specific documents.

The system requirements are:

Server Requirements

- CPU: Intel Pentium III-compatible processor minimum recommended.
- Memory: 256 megabytes (MB) of RAM minimum recommended.
- Hard Disk: 550 MB minimum of available disk space. The drive must be formatted as NTFS file system.
- OS: Windows 2000 Server or Windows 2000 Advanced Server operating system, and Windows 2000 Service Pack 1 (SP1) or later.
- Programs: Internet Information Services (IIS) 5.0, Simple Mail Transfer Protocol (SMTP) Service.

Client Requirements:

- CPU: Intel Pentium-compatible 200 megahertz (MHz) or higher processor recommended.
- Memory: Recommended minimum of 64 MB of RAM.
- Hard Disk: 30 MB of available disk space on Windows 2000 systems; 50 MB of available disk space on all other systems.
- OS: Windows 98, Windows Millennium Edition, Windows NT 4.0 with SP6A, or Windows 2000 Professional, Server, or Advanced Server.

Coordinator functions require Windows 2000 Professional, Server, or Advanced Server.

- Programs: Internet Explorer 5 or later. Visual Basic Scripting support is required. (This is included in the default installation of Internet Explorer 5), Microsoft Outlook Express 5.01 or later. SharePoint Portal Server Office extensions require Office 2000 or later.

Table 5 compares Microsoft SharePoint Team Services with Microsoft SharePoint Portal Server:

	Team Services	Portal Server
Core Function	Ad hoc information sharing	Enterprise search
Web Site	Team Web sites (5 - 75 users)	Portal Web sites (75 + users)
Search Capabilities	Documents within team Web site and sub Webs	Across multiple servers and data types
Discussion and Notifications	Discussions Notifications Surveys	Discussions Notifications
Customization	Browser-based, FrontPage 2002, and SDK	Web Parts and SDK
Document Management	publishing	Check-in, check-out Versioning Routing Publishing
Client Applications	Browser Office XP FrontPage 2002	Browser Microsoft Windows Explorer Office 2000 or Office XP
Roles-based Security	- Administrator - Advanced author - Author - Contributor - Browser	- Administrator - Coordinator - Author - Reader
Storage	Microsoft SQL Server	Web Storage System
Licensing	One FrontPage 2002 license for theServer; no separate client access license	Server license and client access licenses (CALs)

Source: SharePoint Technologies, Unlocking the Power of Information Sharing, Microsoft, 2001

Table 5. Microsoft SharePoint Team Services and Portal Server Comparison.

3. MS NetMeeting

NetMeeting is a program that allows people to communicate synchronously with both video and audio, exchange graphics on an electronic whiteboard, transfer files, use text based chat and collaborate in general.

Microsoft's NetMeeting integrates audio, data, and videoconferencing into one package. Its data-conferencing features allows users to draw on a shared whiteboard, send text messages, transfer files, and collaborate in real time with multiple people within any Windows application. NetMeeting's real-time audio features allow users to talk to other people over the Internet. The program has a Web-based Internet directory and a smaller task-based user interface that can be embedded in a Web page via an ActiveX control. Shared programs appear in new windows on the desktop and can be resized or minimized. NetMeeting calls can be placed to telephones and videoconferencing systems through the use of gateways or gatekeepers. Another feature is Remote Desktop Sharing, which allows accessing and using one computer from another by sharing the desktop. Other features include lower bandwidth requirements for faster performance, support for 24-bit true color, enhanced security, and, on faster multimedia machines and high-speed networks, NetMeeting can achieve up to 30-frames-per-second video performance. NetMeeting's Microsoft Internet Directory supports the new version of MSN Messenger so users can find people on the Internet more quickly.

NetMeeting features allow users to place calls using directory servers, conferencing servers, and Web pages. NetMeeting makes it easier to place calls over the Internet, the organization's intranet, and with telephones.

Users can work easily with other meeting participants by sharing programs. Only one computer needs to have the program, and all participants can work on the document simultaneously. In addition, people can send and receive files.

NetMeeting's audio and video let users see and hear other people. Even if one of them is unable to transmit video, he/she can still receive video calls in the NetMeeting video window. NetMeeting is H.323 compliant.

With the Chat feature, users can talk with multiple people. In addition, Chat calls can be encrypted, ensuring that meetings are private.

Using the Whiteboard, users can explain concepts by diagramming information, using a sketch, or displaying graphics. Participants can also copy areas of their desktop or windows and paste them to the Whiteboard. The Whiteboard is T.126 compliant and is interoperable with other T.126 compatible whiteboards.

Microsoft NetMeeting is free and the system requirements to install and run it are (the program is included in Windows 2000 operating system as a feature):

- CPU: 90 MHz Pentium processor
- Memory: 16 megabytes MB RAM for Microsoft Windows 95, Windows 98, Windows Me, 24 MB RAM for Microsoft Windows NT version 4.0 (Microsoft Windows NT 4.0 Service Pack 3 or later is required to enable sharing programs on Windows NT)
- Programs: Microsoft Internet Explorer version 4.01 or later
- Others: 28,800 bps or faster modem, integrated services digital network (ISDN), or local area network (LAN) connection (a fast Internet connection works best). Sound card with microphone and speakers (required for audio support)
- Hard Disk: 4 MB of free hard disk space (an additional 10 MB is needed during installation only to accommodate the initial setup files)

To use the data, audio, and video features of NetMeeting, the computer must meet the following hardware requirements:

- CPU: For Windows 95, Windows 98, or Windows Me, a Pentium 90 processor with 16 MB of RAM (a Pentium 133 processor or better with at least 16 MB of RAM is recommended)
- Memory: For Windows NT, a Pentium 90 processor with 24 MB of RAM (a Pentium 133 processor or better with at least 32 MB of RAM is recommended)
- Hard Disk: 4 MB of free hard disk space (an additional 10 MB is needed during installation only to accommodate the initial setup files)
- Others: 56,000 bps or faster modem, ISDN, or LAN connection, sound card with microphone and speakers (sound card required for both audio and video support). Video capture card or camera that provides a Video for Windows capture driver (required for video support).

The application sharing and remote desktop sharing, with the video teleconferencing capability, are the most powerful collaborative features making this tool a very simple and good synchronous collaborative application. Another advantage is this is a free program and is compliant with the T.120 and H.323 standards.

4. Windows Messenger for Windows XP

This program replaces in certain way NetMeeting. Windows Messenger is a synchronous tool designed to make people come together and is included in the Windows XP operating system (note: Windows XP come with version 4.0; version 4.6 is available for download free of charge at Microsoft web site). It integrates the features and capabilities of NetMeeting and previous version of Messenger into one application, but with newer technologies, which gives better performance.

Windows Messenger capabilities and features are:

- Video/audio teleconferencing
- File transfer
- Whiteboard
- Application sharing
- Instant messaging (IM)
- Remote control of the computer
- Presence indicator (awareness)

Windows Messenger is compliant with the T.120 and H.323 standards. It is also Session Initiation Protocol (SIP) compliant. SIP is a new Internet Engineering Task Force (IETF) protocol that allows flexible integration of messaging, presence, multimedia conferencing, and real-time communications like telephony.

A major innovation in Windows Messenger is its “forward-error correction” technology that reduces audio and video streams delays when there is more Internet traffic than the system can handle. It can also select voice and video coder and decoder (codecs) that match network conditions in the moment. When there is plenty of bandwidth available, Windows Messenger loads a codec that can provide sound quality that exceeds what we’re accustomed to on the telephone. As network delays increase, it automatically and seamlessly switches to slower speed codecs, providing the best possible level of quality at all times. Another new technology, “acoustic echo cancellation”, reduces the feedback echo that frequently plagues users who place PC-to-PC audio calls over the Internet. The fact that is part of the operating system can also be considered as an advantage because it is fully integrated and doesn’t require an extra installation. Figure 21 shows a screen shot of Windows Messenger for XP.

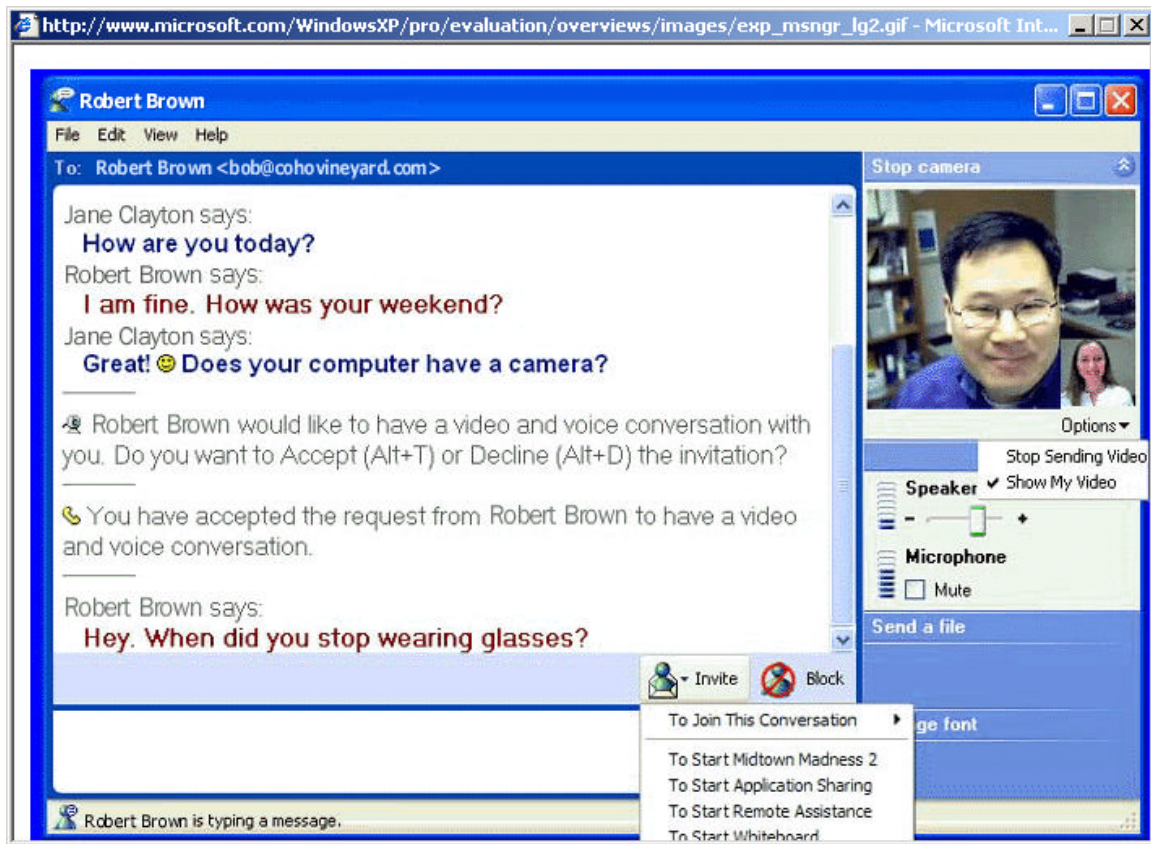


Figure 21. Collaborating with Windows Messenger for XP.

The system requirements are:

- CPU: Intel Pentium/Celeron or AMD K6/Athlon/Duron family processors with 300 Mhz or higher processor speed
- OS: Windows XP Professional or Windows XP Home Edition
- Hard Disk: 10MB available for installation
- Memory: 128MB of RAM or higher recommended (64MB minimum supported; may limit performance and some features)
- Video Display: Super VGA (800 x 600) or higher resolution video adapter and monitor
- For networking: network adapter appropriate for the type of local area, wide area, wireless or home network user wants to connect to, and access to an appropriate network infrastructure. For text instant messaging, voice and videoconferencing, and application sharing, both parties need Microsoft .NET passport account and Internet access or Microsoft Exchange 2000 Server instant messaging account and network access.

C. SUN MICROSYSTEMS - SUNFORUM

SunForum 3.2 is the standards based application suite, which provides video conferencing and collaborative tools to Sun desktop products. It uses industry standard protocols (T.120 and H.323) to enable Sun desktops to conduct cross-platform audio/video conferencing, VoIP communication, share applications, shared whiteboard sessions, and transfer files with colleagues using Sun, Windows, or other UNIX desktop solutions.

SunForum is designed to support a workgroup of 10 or fewer participants. For more than 10 participants, a conference server has to be considered.

Main features of this product are the following:

- Audio/video conferencing
- Shared whiteboard
- Shared applications
- Shared clipboard
- File transfer and chat
- Voice over IP
- Multipoint and multicast videoconferencing
- Compatibility with T.120 and H.323 based products
- LDAP server support
- Directory sort/search
- Full duplex audio

The suite is composed of the following data collaboration tools:

- Video Conference Manager: SunForum H.323 videoconference can be either point-to-point (unicast) or multipoint (multicast). A SunForum to SunForum videoconference can use multicast to create a multipoint videoconference. Multicast H.323 videoconference enables users to transmit and receive from several users at the same time. Multicast or multipoint conferences therefore enable several people to join in a single conference. Since some products like Microsoft NetMeeting, support unicast only, a SunForum to NetMeeting videoconference must be point-to-point and only two people can exchange video and audio at a time.
- Shared application: This application lets multiple users interact with a live application simultaneously, in real time, with participants having the same

view on their workstations. Remote users need any T.128-based shared application utility loaded, but they don't need to have the application being shared baded on their desktops in order to participate in the on-line meeting. Any participant can "drive" the application if the host chooses to "share" that application. Since it adheres to the T.128 standard, it enables SunForum users to share applications in a heterogeneous environment.

- Shared Whiteboard: the shared whiteboard utility is compliant with T.126 standard enabling SunForum users to share a whiteboard with workstations and any other whiteboard application that is T.126 compliant, such as Microsoft NetMeeting.
- File Transfer Utility: this utility is T.127 compliant enabling SunForum users to receive and transfer non-native and native files with other conference participants.
- Chat utility: this utility allows users to chat with other users running SunForum or Microsoft NetMeeting.

These applications and utilities are complemented with Voice over IP (VoIP) capability, which allows users to place and receive telephone calls via their Sun Ray or Sun workstation. The software includes interoperability with H.323/VoIP gateways and IP-PBXs. This is a feature that is unique to SunForum.

The GUI is very friendly and includes five areas: (a) Conference Manager, (b) Application Sharing, (c) Phone Style User interface, (d) Videoconferencing, and (e) Electronic Whiteboard, as seen in Figure 22.

Although SunForum is proprietary, the fact that it is based on the most popular standards allows them to collaborate with other users, even if they are not Sun users.

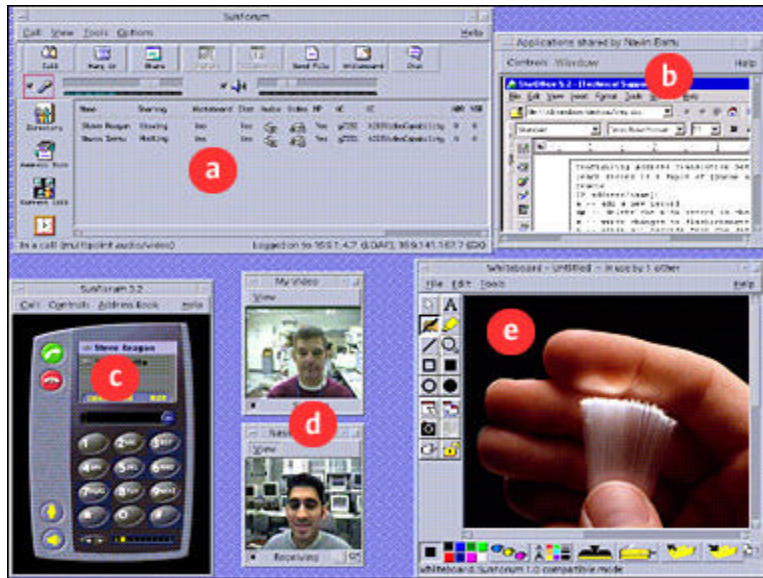


Figure 22. SunForum GUI.

The system requirements are:

- Sun Ultra or Sun Blade workstations
- Sun Ray 1, 100, 150 (Server Software 1.2 or later)
- Solaris 2.6, 7 or 8 Operating Environment
- 20 MB of available disk space (English version)
- TCP/IP connection
- Support for video/audio conference requires one of the following setups:
 - For Sun Blade workstations: Sun IEEE 1394 Visual Collaboration Kit
 - For (PCI based) Ultra workstations: SunVideo Plus 1.3 hardware, an analog, video conferencing NTSC/PAL camera, and computer style headset and microphone
 - For Sun ray appliances: analog video-conferencing, NTSC/PAL camera with computer style headset and microphone

This product is available for download free of charge at Sun Microsystems web site.

D. IBM/LOTUS

1. SameTime

The SameTime product family includes the SameTime Server, the SameTime Connect client and a range of Application Developer Tools. The SameTime Server supports the T.120 standard and is designed to work smoothly with third-party clients such as Microsoft NetMeeting.

SameTime can be used directly by clients who have the SameTime desktop software installed or with a browser client. The desktop client allows the user to create his or her own group of team members, see who is online, participate in or initiate conversations and control the online status that other users see.

SameTime emphasizes the advantages of real-time communications along with the integration of synchronous applications with asynchronous work styles. The product includes chat and instant-messaging applications as well as a shared whiteboard feature. While SameTime is fully integrated with the Domino platform, it can operate independently of Lotus's products. It integrates not only with Notes and Domino, but also with any standard Web browser or T.120-based client. In fact, any Web application can easily be SameTime-enabled to add real-time collaboration and application sharing capabilities.

SameTime services fall into three areas:

- Conferencing services: these services include a shared whiteboard and the ability to share programs and documents online. It offers also a server-based Meeting Center where users can schedule online meetings in advance and store agendas and other meeting materials. Users can share objects, such as desktop applications, presentations, documents, and drawings on line. Other participants are not required to have the same software in order to participate and see what is being shared. When appropriate, users can also pass control of the application back and forth as necessary; the initiator can reassert control at any time.
- Secure Instant Messaging Services: these services include awareness, instant messaging, and chat. A buddy list makes SameTime users aware of who is available and who is online but unavailable to receive an instant message or participate in a chat with one or more people. SameTime can obtain the identities of users directly from the enterprise directory, such as the Domino Directory, or form its own integrated directory. These

services can also be provided to users outside the firewall through interaction with America Online's Instant Messenger (AIM) service (administrators determine whether this SameTime capability is enabled or not).

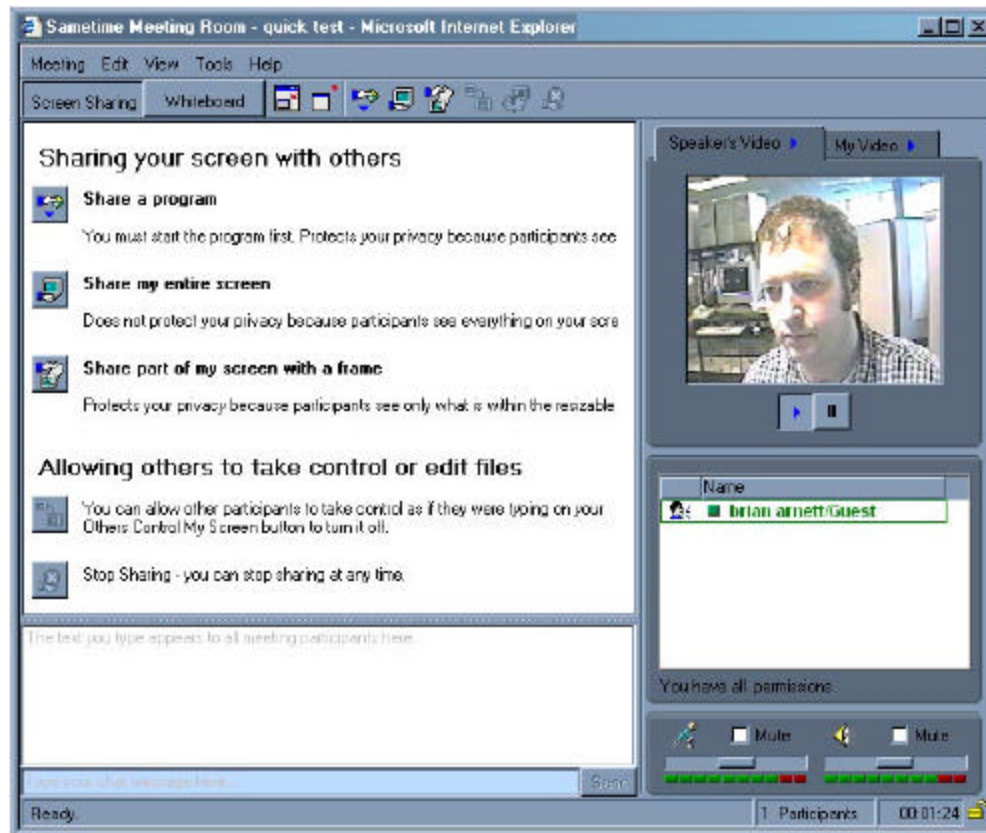
- Integration Services: SameTime also provides a comprehensive Java-based API that enables customers to easily integrate real-time collaborative capabilities into other applications. These tools include a full set of applets and component services for awareness, real-time chat, instant messaging, shared whiteboards and screen sharing. Although Lotus notes or Domino are not required to get the full functionality of SameTime, a user in a Domino environment, can make use of pre-enabled Domino templates to add awareness and instant messaging capabilities to Domino-based mail databases to include online users as mail recipients, discussion databases, and document libraries.

SameTime provides some useful security features. Users are authenticated when they access the SameTime Server ensuring that people are really who they say they are. Moreover, data from object sharing sessions can be encrypted to protect meeting content from unauthorized viewing. Chat transmission data is also encrypted and can be saved in a text file for review at a later time.

Another security feature is a proxy service, which is installed in the “demilitarized zone” of the network, and allows external users to access the server without compromising network security.

In the awareness and conversation mode, thousands of users can be supported. Object sharing sessions allow hundreds of people to view the same application or presentation whiteboard. Multiple SameTime Servers can be linked together to increase scalability and reduce traffic across the network which is important when video is being transmitted.

Figure 23 shows a screen shot of a video conferencing using SameTime.



Real time video conferencing using SameTime

Figure 23. Real time Video Conferencing using SameTime.

SameTime can be deployed as a standalone network or integrated with an existing messaging infrastructure such as Lotus Domino or Microsoft Exchange.

The Lotus Translation Services for SameTime (LTSS) makes it easier for organizations to collaborate internationally. LTSS connects SameTime to the IBM Translation Server or to another third party Translation Servers available from Transparent Language, Alis Technologies, and Systran. A user can send an instant text message in English to a Spanish speaker for example, and the message is automatically translated from English to Spanish.

Network Magazine declared SameTime 2.0 as Product of the Year 2000 in the Messaging and Email category stating, "Version 2.0 goes beyond IM, supporting all kinds of real time collaborative working".

According to a Gartner Group report, the major strengths of SameTime are immediacy, scalability, performance, simplicity and chat fit for business. Its major limitations are a limited platform, possibility of security compromises and its text orientation. Version 2.5, however, provides increased platform support for example for Sun Solaris, IBM zSeries, iSeries, pSeries and Windows server platforms.

The system requirements are:

SameTime Server:

- CPU: Pentium II 300MHz or higher
- Operating systems: Windows 2000 Professional or Windows NT with Service Pack 5
- Memory: Windows NT: Minimum 128MB; 256MB RAM or more recommended; Windows 2000: Minimum 192MB; 320MB RAM recommended
- Disk space: 300MB of free disk space. 500MB is recommended to allow space for meetings, applications and databases
- Disk swap space: 64MB

SameTime Client Options:

- CPU: Pentium II 233 MHz or higher
- Operating Systems: Windows 95 OSR2, Windows 98, Windows 98SE, Windows NT Workstation 4.0, SP5, Windows 2000 Professional
- Browser: Internet Explorer 4.01 with Service Pack 2 (or higher), Internet Explorer 5 or later, Netscape Navigator 4.5 or higher
- Network Software: TCP/IP network software installed
- Memory: 96MB RAM for Windows 2000 Professional or Windows NT with Service Pack 5. 64MB RAM for Windows 98, Windows 98SE or Windows 95

Additional client requirements for Audio/Video:

- Sound card: A full-duplex sound card is required to participate in interactive audio/video meetings. A half-duplex sound card is required to enable a user to listen to an audio/video meeting broadcast by the SameTime Broadcast Services
- Microphone and speakers: A good quality microphone and speakers are recommended. Microphones with on and off switches should not be used unless they are of high quality. A headset that contains a boom microphone performs best. If a desktop microphone is used, a unidirectional dynamic microphone that uses batteries is preferred.

- Video capturing software: Video for Windows
- Camera: A high-quality USB or PCMCIA PC camera and not a parallel port camera. A camera is optional. Users who do not have a camera can participate in an audio/video meeting. When a user without a camera speaks no video is displayed to other users in the meeting.

The Lotus SameTime per-user license with one year of software maintenance is available for a suggested price of \$38.42 per user.

2. QuickPlace

This product is advertised by IBM/Lotus as a “self-service tool for web-based team collaboration improving the team communication/collaboration process, the time to response and action, navigation of information, and the ability of team members to participate in the planning, creation, and sharing of content and deliverables. QuickPlace lets community members create a secure, Web-based collaborative workspace easily. Collaborators can use QuickPlace to share and organize ideas, review documents, and collaborate on any kind of project or ad hoc initiative.”

In fact, QuickPlace is a powerful tool that allows users to create secure and web-based workplaces easily. It offers also a full spectrum of integrated services for team collaboration, including project management tools, Microsoft Office integration and integrated workflow.

A secured workspace is first created on a chosen server, usually the project manager's or project leader's. The workspace administrator requires a Windows NT 4.0 server or Windows 2000 Professional/Enterprise to ensure that the workspace is tightly secured from invaders on the Net.

QuickPlace can also "sit" on top of Lotus Domino as both are compatible. Once the workspace is created, a unique uniform resource locator (URL) is given so that team members can access this workspace for instant collaboration.

Project content, sense of time such as tasks, milestones, meetings, events and even newsletters and chat facility, process flow, identity and knowledge can be shared among team members instantly even if they are miles apart.

Also, QuickPlace is more adaptive to member's work as it is seamlessly integrated with Microsoft Office and users can write and publish Office documents or templates of any type as customized QuickPlace forms. Also, the built-in task management feature always keeps the project on schedule as it allows them to monitor areas in the project that are lagging.

Action items and deadlines are mapped progressively on a Gantt chart where everyone can see tasks and deadlines or the entire project as a whole. QuickPlace also automatically notifies team members about the "to dos" and status of milestones.

To make the user feel at home, QuickPlace allows users to customize everything that appears in the workspace, be it folders and forms, the look and feel of the workspace layout or just adding themes such as a Windows Desktop Shell that mirrors an existing corporate Web site. Users can even create solution modules which address specific needs.

All the contents in the QuickPlace workspace are fully text-indexed with a choice of folder styles enabling users to organize content intuitively for easy retrieval.

There is also a daily or weekly news provider via an integrated interface which allows access to the latest content and actions.

Although QuickPlace is Web-based, users do not necessarily have to be connected to the Internet all the time. Should they wish to go off- line, they can still continue their work in a "standalone" mode and QuickPlace will automatically synchronize the data once reconnected.

One plus-point of QuickPlace is that its data is always up-to-date and the workspace flows into real-time as the project progresses because everything is self-service, and as long as users are online, collaboration is immediate.

QuickPlace is an out of the box usable product, but in order to obtain better solutions, it can be customized.

As with SameTime, QuickPlace works equally well in both Domino and non-Domino solutions.

During this thesis work, a QuickPlace was created in order to see all its features. First of all, as the company advertises, it is very easy and fast to set up the team

workspace. A URL was assigned and a home page created. For this trial, Lotus provided access to one of their servers for a period of 45 days free of charge. Figure 24 shows the home page.

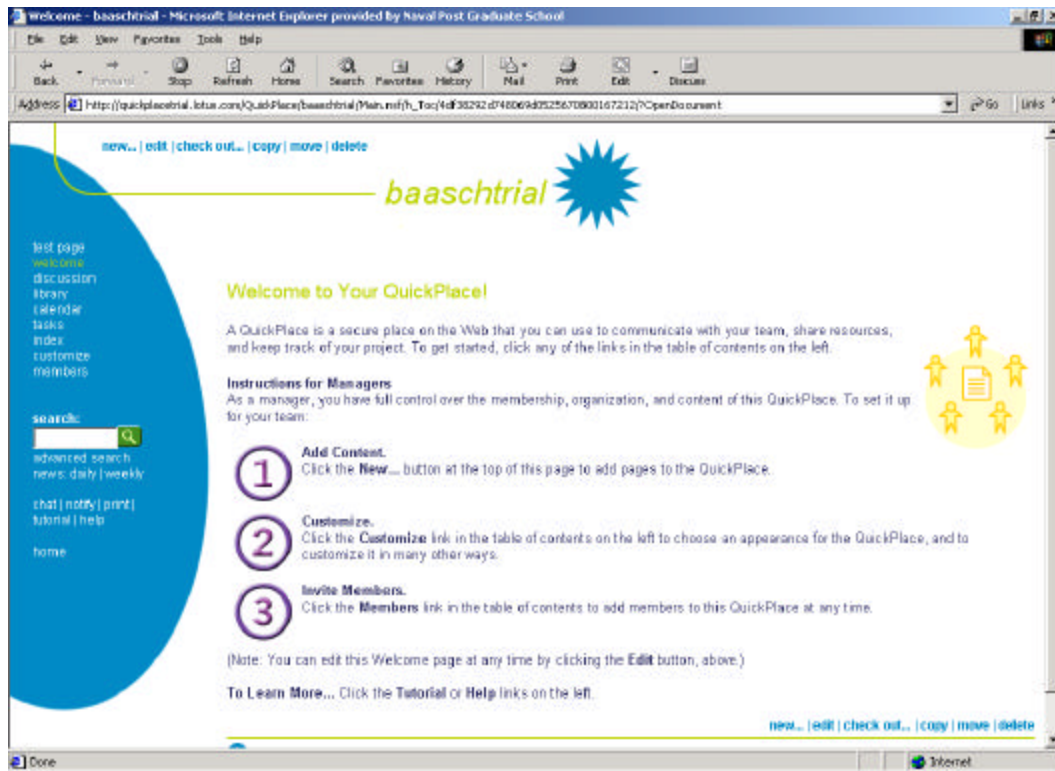


Figure 24. QuickPlace Home Page.

The site included discussion boards, a document library where members can upload documents, a calendar where all the team activities can be scheduled and displayed, a tasks list, an index, a customization menu, the members list where new members can be added, a search menu, news, a chat application and a tutorial.

Creating new pages can expand the QuickPlace. These pages can be imported pages, calendar pages, task pages, Microsoft Word pages, Microsoft Excel pages, Microsoft PowerPoint pages, multiple imported pages, a link page that links to another web page or a folder where several pages can be filed.

The customization menu options include changing the manner in which (place, font and color) the different links and information appear on screen, changing

backgrounds, textures, work offline and creating forms for authors to fill out. These forms can have useful fields such as pop-up lists or date pop-ups, and a workflow that moves the form from one member to another as it is filled out. Another feature is that QuickPlace is extendable by creating “rooms”, which allows the creation of private spaces in which a subset of the QuickPlace members can meet. Groups might exist without creating rooms.

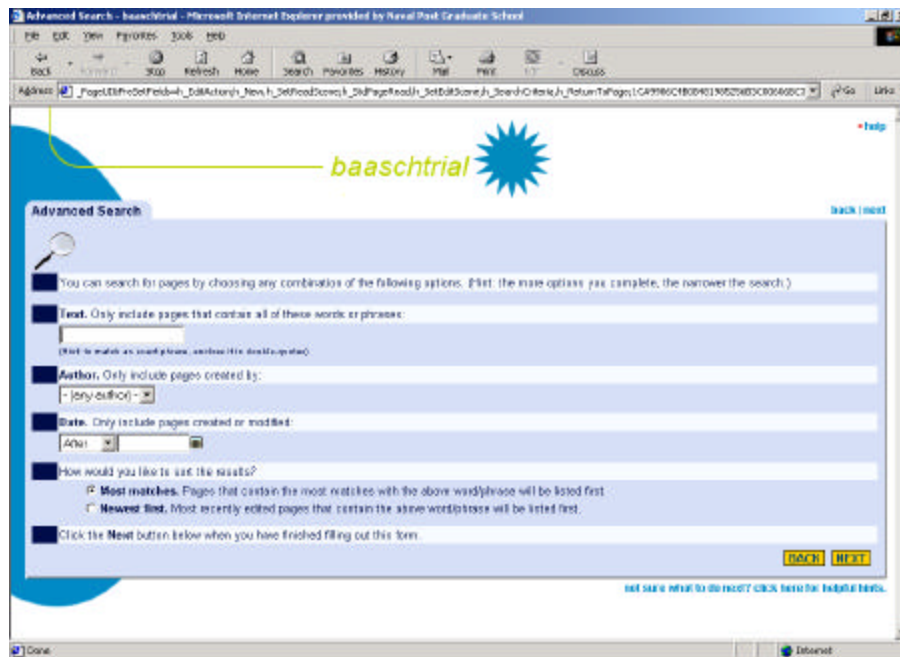


Figure 25. QuickPlace Advanced Search Page.

If one of the members needs a document and does not know where it is stored, or needs to know if something related to a specific topic was published on the site, a search engine allows a search by text and/or author and/or date. This provide much flexibility.

What makes this product interesting is that it is totally 100 percent self-service Web-based, meaning that QuickPlace enables the creation of a team workspace on the Web instantly. Teams can then use QuickPlace to share and organize ideas, content and tasks around any project. QuickPlace provides a central online workspace area.

The system requirements are:

Server:

- 150 MB minimum free disk space, 200 MB recommended
- 128 MB minimum memory, 256 MB recommended
- Platform: Windows NT 4.0 Service Pack 4 or above
- Video Card: 256 colors minimum, True Color recommended

Browser Client:

- PC Compatible: MS Internet Explorer 4 & SP2, MS Internet Explorer 5
- PC Compatible: Netscape 4.5x, Netscape 4.6x, Netscape 4.7x
- PC Compatible: Lotus Notes 4.6 and above using integrated MS Internet Explorer 4 and above
- Macintosh Compatible (browsing and authoring support): MS Internet Explorer 5
- Macintosh Compatible (browsing and authoring support): Netscape 4.5x, Netscape 4.6x, Netscape 4.7x

Operating Systems:

- Win95, Win98, WinNT4
- Win2000 is supported as a server and client, but is not certified
- System 8.6, System 9
- iSeries V4R3 or later
- AIX 4.3.3
- Solaris 8 (supported in QuickPlace Release 2.0.5)
- IBM S/390 (supported in QuickPlace Release 2.0.7)

The price of this product is \$40 for digital delivery and \$57 for boxed delivery per user. The server price is \$8,645.

E. CYBOZU – SHARE 360

Share 360 is a web-based groupware suite, which integrates collaboration applications in order to provide Intranet solutions for small and medium sized companies and workgroups within larger organizations. With this application group members can access email, schedules, contacts, tasks, announcements, memos, files, projects and organization forms.

Share360 is a 5th generation office suite formerly known as "Cybozu Office 4". The product is multi-platform and runs on Linux and Windows and is known for its ease of use and installation process in minutes. It is centrally managed on the customer's web server and is accessible from client PCs with any operating system through a Web browser. It integrates 11 web-based applications into one suite:

- Address Book: centralizes all organization contacts, employee lists as well as a person's personal contacts
- Bulletin Board: allows the posting of group announcements and the dissemination of important information immediately to the desktops of all employees
- Cabinet: a central repository for all the group or project shared documents can be created. It includes version control to facilitate efficient collaboration.
- Discussions: this application allows group members to interact and converse in real time without being in the same location using their browsers. It includes threaded discussions.
- Memos: this tool is used to send important news to specific co-workers, and track responses of the recipients online and in one place
- Project: tool used to manage multiple projects with formal goals, tasks and timeline tracking
- Scheduler: used to keep track the schedule of the different team members. It has different views.
- To do list: a way to organize people's tasks and responsibilities. It is possible to assign tasks to a specific person or to a group.
- Web forms: users can create online forms without knowing HTML. Forms can be routed electronically throughout the organization for quick online approvals.
- Web mail: this a web-based email system which is integrated into the suite and make it possible to send and receive emails. It complies with SMTP/POP3 Internet standards so it is easy to set up and use.
- Whereabouts: a tool to have control over where other members of the team are and to let others to know the location of each user. It indicates if a team member is in the office or somewhere else with the time stamp of the changed state. The user can customize which member's whereabouts to show.

These applications can be complimented with Share360 Sync for Palm OS to be used in Palm OS Personal Digital Assistants (PDAs).

Figure 26 shows the home page of a Share360 example (from Cybozu web site trial version):

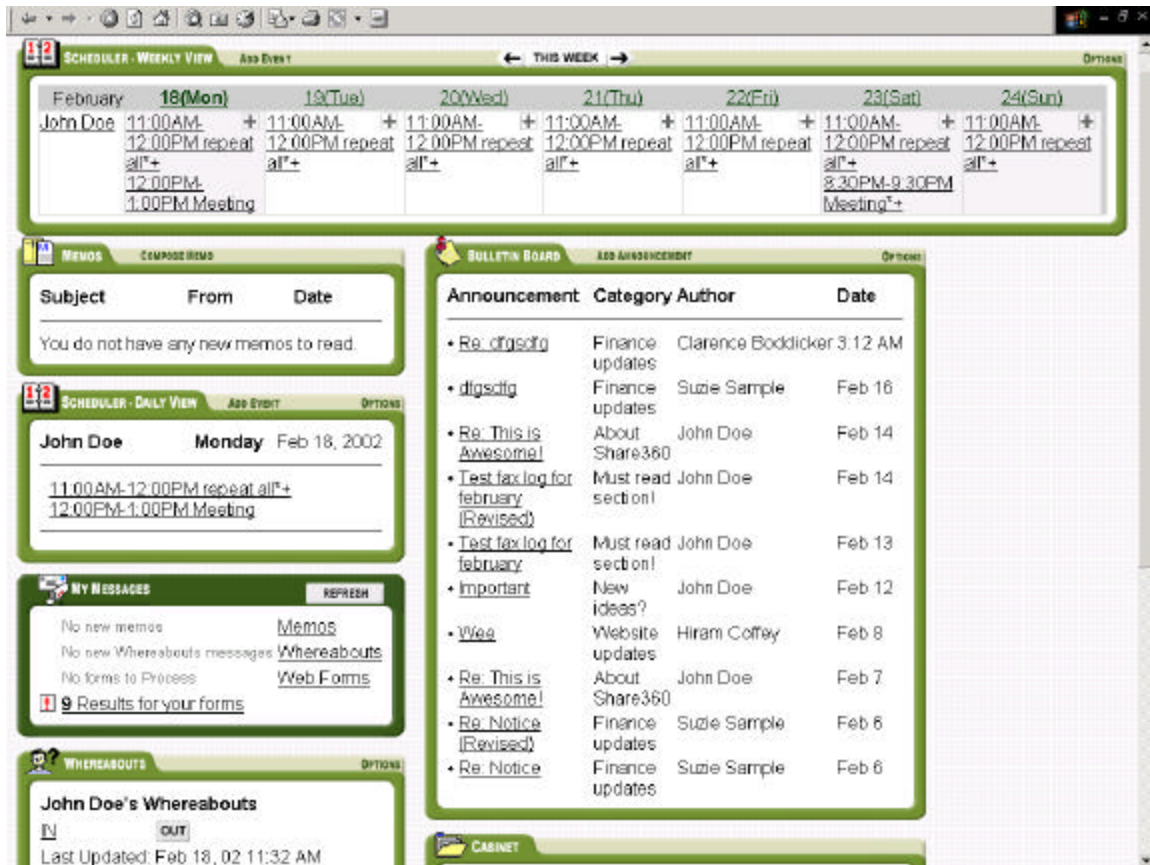


Figure 26. Share 360 Example Page.

The system requirements are:

- Software Server OS: Windows 98, Windows NT Server 4.0/Workstation 4.0, Windows 2000 Server/Professional, Windows XP Professional or Linux (Kernel version 2.x)
- Client Browser: Netscape Navigator 4.0 or later. Internet Explorer 4.0 or later
- Web Server: IIS 2.0/3.0/4.0/5.0 for Windows NT/2000/XP. Peer Web Services for Windows NT Workstation 4.0. Personal Web Server 4.0 for Windows 98. Apache 1.1 and later for Linux (Kernel version 2.x). Share360 Cybozu Web Server

- Server Hardware: Intel Pentium 90 Mhz. 32MB RAM (64MB recommended).25MB HD (50 MB recommended)

Share360 is offered in two packages, the Share360 Standard and the Share360 Complete, or as individual applications and the pricing varies according to the number of users. The complete package includes the 11 applications and costs from \$1,298 for 10 users up to \$14,998 for an unlimited number of users. The Standard package includes only 9 applications and costs from \$898 for 10 users up to \$8,998 for unlimited number of users. Web forms and projects are not included. Both packages can be purchased for 10, 30, 50, 100 or an unlimited number of users.

Share360 Sync for Palm OS costs from \$98 per user for one to two users down to \$28 per user for more than 100 users.

F. COMPARISON TABLE

When comparing these tools, the most common difference is whether they support synchronous or asynchronous collaboration. Most companies offer both types of tools to satisfy organizations with different collaboration requirements and needs. Different tools of same vendors are also integrated in suites. Other companies specialize in only one type of collaboration where they focus all their efforts.

For synchronous collaboration, the T.120 and H.323 standards are widely accepted, which allows most of the tools to communicate with each other. In fact, this was the case for all the reviewed tools.

Most of the reviewed tools are similar. The difference in some cases is the scale of the collaborative environment. For example, SharePoint Team Services is designed for small teams, while SharePoint Server Portal is designed for large organizations. Similarly Share360 from Cybozu, is designed for small to medium organizational groups or teams in larger groups. Another difference is the cross platform support. While most of the tools are Windows based, some provide support for Linux or Unix systems. However, tools on different platforms can still collaborate if they share common standards.

All tools have a common client/server architecture. However, peer-to-peer architecture is emerging as an option for collaborative environments. The most famous peer-to-peer tool is Groove, from Groove Networks, which has the same features of the synchronous tools described in this chapter.

Using the same classification presented in Chapter III (time/place framework), Figure 27 shows the different tools included in this chapter in their corresponding place in the framework:

		TIME →	
		Same	Different
PLACE ↓	Same	(Meeting Rooms)	(Work Shifts)
	Different	NetMeeting SameTime Messenger SunForum	Share360 SharePoint QuickPlace

Figure 27. Analyzed Tools Time/Place Domain Classification.

Appendix D shows a detailed comparison of the different tools according to synchronous or asynchronous criteria. Most of the tools fall clearly in either one classification of synchronous or asynchronous, but some of them have a few features from the other type, which makes them hybrid collaborative tools.

VI. CONCLUSIONS

A. SUMMARY

This thesis introduced collaboration as an important activity in modern organizations. It presented several definitions which were complemented with examples of different types of collaboration. Also a framework for collaboration, based on time and space domain, was presented.

The role of technology, as an enabler for collaboration, was discussed, and different collaborative technologies were presented. These technologies were classified according to the time/space framework and the most common architectures and protocols were also discussed.

The characteristics of an ideal collaborative environment were then discussed, and different methodologies to develop information systems were introduced. These methodologies were synthesized, and a methodology for developing collaborative systems was proposed. A prototype expert system was developed to help users determine which collaborative technologies are appropriate for an organization's specific set of collaborative requirements.

A comparative analysis of some of the existing collaborative tools was performed. The tools chosen for analysis were based on their popularity, market share, and relevance to DOD.

B. CONCLUSIONS/LESSONS LEARNED

Collaboration occurs in modern organizations and is necessary in order to leverage the knowledge of its knowledge workers. Moreover, it is a core process of Knowledge Management, one of the most important management philosophies today. Frequently collaboration is associated with just technology, but collaboration is much more. It is a process that incorporates many factors, such as organization's culture, internal politics and managerial issues. All of them have to be considered in order to have a successful collaborative effort.

It is necessary to follow a formal methodology, in order to develop a collaborative application. Without one it is difficult to build an application that addresses the organization's collaborative needs. A common mistake organizations fall into is choosing a collaborative tool fast and then modify their environment and/or procedures to fit that tool. This is clearly the wrong approach. If no methodology is used, a chosen tool might not address the real collaborative requirements of that organization.

A collaborative environment methodology should include the traditional phases of analysis, design, and implementation. Appropriate techniques and tools should support each phase. These include questionnaires, interviews, etc. An expert system could be particularly useful in capturing the user's requirements and recommending collaboration technologies to meet that need.

An ideal collaborative environment should include the ability to rapidly find the right people with the right expertise, quickly organize and conduct virtual teams and meetings, deliver the right information to the right people as soon as it is available, provide, maintain sufficient security and employ technology and community standards, allow different types of collaboration, and keep a record of all collaborations for further reference. It is important to realize that collaborative requirements are different for every organization, because every organization has its own collaborative needs. In addition to the ones above generic characteristics that are applicable in most organizations, each organization has specific requirements that address time, place, type of data, action to be done, and audience of the collaboration effort.

A good collaborative tool includes the following characteristics: simplicity, standardization, reliability, scalability, security, interoperability, and configurability. These characteristics to a greater extent should be present in any tool selected. Another essential requirement today for the tool to be web-based, since most of the collaboration with and across organizations is done by means of public or private networks using browsers and TCP/IP protocols. Existing tools can be classified broadly as synchronous or asynchronous. Some tools incorporate technologies from both types in hybrid implementations, but those are few. Large companies tend to have individual tools in

both groups, but integrate them as suites of collaborative tools. Smaller companies focus and specialize in one type.

In order to have successful collaboration, organizations need to have an adequate and strong IT infrastructure. This infrastructure, based on data and communication networks, is the platform for deploying any collaborative technologies and tools. Two architectures are common: client/server and peer-to-peer. Client/Server is the most dominant architecture, and the majority of the existing tools use it today. Peer-to-peer tools are increasingly gaining acceptance in the market place. Benefits of the peer-to-peer architecture are the reduced amount of centralized and storage resources, and the optimization of network and computing resources.

In terms of standardization, T.120 and H.323 are the most popular and all of the analyzed tool adhere to them, making it easy to interoperate and collaborate between each other.

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APPENDIX A. QUESTIONNAIRE

Name:

Position:

Age:

Years working in the organization:

Years in the actual position:

(1) In your daily activities, do you have to interact with other people?

☐ Yes

☐ No (skip to question 10)

(2) Your interaction with others is mainly done with all of you in the same place, or are you at different places?

☐ Different

☐ Same place

☐ Both

(3) What type of data do you exchange/share/send/receive/request?

☐ Text

☐ Audio

☐ Video

☐ Files

☐ Drawings

- Presentations
- Applications
- Desktop
- Schedules
- Task assignments
- Calendars
- Documents

(4) In your interaction, do you need immediate response or action by your counterpart, or it can take a while?

- Immediate (less than 2 minutes)
- Not immediate (more than 2 minutes)

(5) What is the purpose of the interaction?

- Share
- Send / Receive
- Display / Present
- Discuss
- Decision making
- Index / Search
- Manage

(6) How many people participate in the interaction?

- | | |
|------------------------------------|----------------------------|
| <input type="radio"/> 2 | Type of interaction: _____ |
| <input type="radio"/> 2 – 5 | Type of interaction: _____ |
| <input type="radio"/> 5 – 10 | Type of interaction: _____ |
| <input type="radio"/> more than 10 | Type of interaction: _____ |

(7) Do you require making annotations on the shared document/graphic?

- ☐ Yes
- ☐ No

(8) Do you require making changes on the shared document/graphic?

- ☐ Yes
- ☐ No

(9) Do you think that current collaboration practices are good? Why? Specify.

- ☐ Yes
- ☐ No
- ☐ Why

(10) Would you like to introduce new collaboration tools into the organization? Why? Specify.

- ☐ Yes
- ☐ No
- ☐ Which and why

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APPENDIX B. GUIDELINES FOR INTERVIEW

Interview Guide

Interviewee Name:

Interviewee Position:

Date/Time:

Place:

Subject:

<u>Time allocated</u>	<u>Interviewer question or objective</u>	<u>Interviewee response</u>
1 to 2 min.	Objective: open the interview Introduce yourself Thank interviewee for valuable time State purpose of interview Obtain an understanding of the collaboration in the organization	
5 min	Question 1	
5 min	Question 2	
3 min	Question 3	
1 min	Question 4	
1 min	Question 5	
1 to 3 min	Question 6	
1 min	Objective: conclude the interview Thank the interviewee for the cooperation assuring him that he will receive a copy of what was recorded	

General Comments and Notes:

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APPENDIX C. DECISION TREE

REQUIREMENTS					COLLABORATIVE TOOL	OTHER CHARACTERISTICS		
PLACE	TIME	ACTION	DATA	AUDIENCE		ANNOTATIONS	CHANGES	RESPONSE
Same	Same	Share	Applications	Small	Applications Sharing	Yes	Yes	Immediate
				Medium	Applications Sharing			
		Desktop		Small	Desktop sharing	Yes	Yes	Immediate
				Medium	Desktop sharing			
		Send/Receive	Text	Small	Chat	N/A	N/A	Immediate
				Medium	Chat			
		Files	Any number		File Transfer	N/A	N/A	Not immed.
		Display/Present	Drawings	Small	Whiteboard	Yes	No	Immediate
				Medium	Whiteboard			
			Presentations	Small	Whiteboard			
				Medium	Whiteboard			
		Discuss	Text	Small	Chat	N/A	N/A	Immediate
				Medium	Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both
					Chat	N/A	N/A	Immediate
			Large		Web-based GSS	Yes	Yes	Both
					GSS in decision room			
					Web-based GSS	Yes	Yes	Both
					GSS in decision room			
			Video	Medium	Web-based GSS	Yes	Yes	Both
					GSS in decision room			
				Large	Web-based GSS	Yes	Yes	Both
					GSS in decision room			
			Audio	Medium	Web-based GSS	Yes	Yes	Both
					GSS in decision room			
				Large	Web-based GSS	Yes	Yes	Both
					GSS in decision room			
			Files	Medium	Web-based GSS	Yes	Yes	Both
					GSS in decision room			
				Large	Web-based GSS	Yes	Yes	Both
					GSS in decision room			
			Drawings	Small	Whiteboard	Yes	No	Immediate
				Medium	Whiteboard			
			Presentations	Small	Whiteboard			
				Medium	Whiteboard			
		Decision making	Text	Small	Chat	N/A	N/A	Immediate
				Medium	Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both
					Chat	N/A	N/A	Immediate
			Large		Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both
					Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both
			Video	Medium	Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both
				Large	Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both
			Audio	Medium	Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both
				Large	Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both
			Files	Medium	Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both
				Large	Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both

REQUIREMENTS					COLLABORATIVE TOOL	OTHER CHARACTERISTICS		
PLACE	TIME	ACTION	DATA	AUDIENCE		ANNOTATIONS	CHANGES	RESPONSE
Same	Different	Share	Documents	Any number	Document Management	N/A	Yes	Not immed.
			Schedules, Calendars, Tasks	Medium	Workflow	N/A	Yes	Not immed.
				Large	Workflow			
		Index/Search	Documents	Any number	Document Management	N/A	Yes	Not immed.
		Send/Receive	Files	Any number	File Transfer	N/A	N/A	Not immed.
			Text	Any number	Threaded Discussions	N/A	N/A	Not immed.
		Discuss	Text	Medium	Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both
				Large	Web-based GSS	Yes	Yes	Both
			Video		GSS in decision room	Yes	Yes	Both
				Medium	Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both
			Large		Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both
					Web-based GSS	Yes	Yes	Both
			Audio		GSS in decision room	Yes	Yes	Both
				Medium	Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both
			Large		Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both
					Web-based GSS	Yes	Yes	Both
		Decision making	Text	Medium	GSS in decision room	Yes	Yes	Both
					Web-based GSS	Yes	Yes	Both
				Large	Web-based GSS	Yes	Yes	Both
			Video		GSS in decision room	Yes	Yes	Both
				Medium	Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both
			Large		Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both
					Web-based GSS	Yes	Yes	Both
			Audio		GSS in decision room	Yes	Yes	Both
				Medium	Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both
			Large		Web-based GSS	Yes	Yes	Both
					GSS in decision room	Yes	Yes	Both
					Web-based GSS	Yes	Yes	Both
		Manage	Documents	Any number	Document Management	N/A	Yes	Not immed.
			Schedules, Calendars, Tasks	Medium	Workflow	N/A	Yes	Not immed.
				Large	Workflow			

REQUIREMENTS					COLLABORATIVE TOOL	OTHER CHARACTERISTICS		
PLACE	TIME	ACTION	DATA	AUDIENCE		ANNOTATIONS	CHANGES	RESPONSE
Different	Same	Share	Applications	Small	Applications Sharing	Yes	Yes	Immediate
				Medium	Applications Sharing			
			Desktop	Small	Desktop sharing	Yes	Yes	Immediate
				Medium	Desktop sharing			
		Send/Receive	Text	Small	Chat	N/A	N/A	Immediate
				Medium	Chat			
			Files	Any number	File Transfer	N/A	N/A	Not imm.
		Display/Present	Drawings	Small	Whiteboard	Yes	No	Immediate
				Medium	Whiteboard			
			Presentations	Small	Whiteboard			
				Medium	Whiteboard			
				Any number	Videoconferencing	N/A	N/A	Immediate
				Small	Chat	N/A	N/A	Immediate
		Discuss	Text	Medium	Web-based GSS	Yes	Yes	Both
				Large	Chat	N/A	N/A	Immediate
				Large	Web-based GSS	Yes	Yes	Both
				Any number	Videoconferencing	N/A	N/A	Immediate
			Video	Medium	Web-based GSS	Yes	Yes	Both
				Large	Web-based GSS			
				Any number	Web-based GSS			
				Any number	Web-based GSS			
			Audio	Medium	GSS in decision room	Yes	Yes	Both
				Large	Web-based GSS	Yes	Yes	Both
				Any number	GSS in decision room	Yes	Yes	Both
				Any number	Audioconferencing	N/A	N/A	Immediate
			Files	Medium	Web-based GSS	Yes	Yes	Both
				Large	Web-based GSS			
				Any number	Web-based GSS			
				Any number	Web-based GSS			
			Drawings	Small	Whiteboard	Yes	No	Immediate
				Medium	Whiteboard			
				Any number	Whiteboard			
				Any number	Whiteboard			
			Presentations	Small	Whiteboard	Yes	No	Immediate
				Medium	Whiteboard			
				Any number	Whiteboard			
				Any number	Whiteboard			
		Decision making	Text	Small	Chat	N/A	N/A	Immediate
				Medium	Web-based GSS	Yes	Yes	Both
				Large	Chat	N/A	N/A	Immediate
				Large	Web-based GSS	Yes	Yes	Both
			Video	Medium	Web-based GSS	Yes	Yes	Both
				Large	Web-based GSS			
				Any number	Videoconferencing			
				Any number	Videoconferencing	N/A	N/A	Immediate
			Audio	Medium	Web-based GSS	Yes	Yes	Both
				Large	Web-based GSS			
				Any number	Audioconferencing			
				Any number	Audioconferencing	N/A	N/A	Immediate
			Files	Medium	Web-based GSS	Yes	Yes	Both
				Large	Web-based GSS			
				Any number	Web-based GSS			
				Any number	Web-based GSS			
			Drawings	Small	Whiteboard	Yes	No	Immediate
				Medium	Whiteboard			
				Any number	Whiteboard			
				Any number	Whiteboard			
			Presentations	Small	Whiteboard	Yes	No	Immediate
				Medium	Whiteboard			
				Any number	Whiteboard			
				Any number	Whiteboard			

REQUIREMENTS					COLLABORATIVE TOOL	OTHER CHARACTERISTICS		
PLACE	TIME	ACTION	DATA	AUDIENCE		ANNOTATIONS	CHANGES	RESPONSE
Different	Different	Share	Documents	Any number	Document Management	N/A	Yes	Not immed.
			Schedules, Calendars, Tasks	Medium	Workflow	N/A	Yes	Not immed.
				Large	Workflow	N/A	Yes	Not immed.
		Index/Search	Documents.	Any number	Document Management	N/A	Yes	Not immed.
		Manage	Documents	Any number	Document Management			
			Schedules, Calendars, Tasks	Medium	Workflow	N/A	Yes	Not immed.
				Large	Workflow			
		Discuss	Text	Any number	Threaded Discussions	N/A	N/A	Not immed.
		Send/Receive	Files	Any number	File Transfer	N/A	N/A	Not immed.
			Text	Any number	Email	N/A	N/A	Not immed.
		Discuss	Text	Medium	Web-based GSS	Yes	Yes	Both
				Large	Web-based GSS			
			Audio	Medium	Web-based GSS			
				Large	Web-based GSS			
			Files	Medium	Web-based GSS			
				Large	Web-based GSS			
		Decision making	Text	Medium	Web-based GSS			
				Large	Web-based GSS			
			Video	Medium	Web-based GSS			
				Large	Web-based GSS			
			Audio	Medium	Web-based GSS			
				Large	Web-based GSS			
			Files	Medium	Web-based GSS			
				Large	Web-based GSS			

APPENDIX D. TOOL COMPARATIVE TABLE

		COLLABORATIVE TOOL							
		COMPANY							
		MICROSOFT				SUN	IBM/LOTUS		CYBOZU
COLLABORATION		SharePoint Team Services	SharePoint Server Portal	NetMeeting	Messenger for Windows XP	SunForum	SameTime	QuickPlace	Share360
SYNCH.	Audio	No	No	Yes	Yes	Yes	Yes	No	No
	Video	No	No	Yes	Yes	Yes	Yes	No	No
	Awareness	No	No	No	Yes	No	Yes	No	Limited
	Chat	No	No	Yes	Yes	Yes	Yes	Yes	No
	Desktop sharing	No	No	Yes	Yes	No	Yes	No	No
	Shared apps.	No	No	Yes	Yes	Yes	Yes	No	No
	Whiteboard	No	No	Yes	Yes	Yes	Yes	No	No
	File transfer	No	No	Yes	Yes	Yes	No	No	No
ASYNCH.	Email	No	No	No	No	No	No	No	Yes
	Discussion	Yes	Yes	No	No	No	No	Yes	Yes
	Group Calendars	No	No	No	No	No	No	Yes	Yes
	Project Mgt.	Limited	Limited	No	No	No	No	Yes	Yes
	Doc. Mgt.	Yes	Robust	No	No	No	No	Yes	Yes

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